KISS

KALINGA INSTITUTE OF SOCIAL SCIENCES

CURRICULUM AND CREDIT FRAMEWORK FOR UNDERGRADUATE PROGRAMME

BACHELOR OF VOCATION IN RENEWABLE ENERGY

(As per NEP-2020, NCrF, NHEQF)

Academic Session 2026-2027



DEPARTMENT OF RENEWABLE ENERGY

SCHOOL OF TRIBAL RESOURCE MANAGEMENT

KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)

DEEMED TO BE UNIVERSITY

Higher Education Campus, KISS Campus-3, Bhubaneswar, Odisha, 751024

https://university.kiss.ac.in | https://kiss.ac.in

SCHOOL OF TRIBAL RESOURCE MANAGEMENT

The School of Tribal Resource Management, KISS Deemed to be University, was established in 2017-18, to address the current and emerging rural development needs of the country and the inadequacy of homogeneous models of development. The School of Tribal Resource Management actively endeavours to equip its academic programme to measure up to local, regional, national and international standards. It may be mentioned here that KISS Deemed to be University is the first full-fledged institution in the field of tribal resource management in the country. Here students receive quality education free of cost.

KISS is now determined to build on this advantage by creating a regular, organized and permanent framework to ensure that the knowledge and wisdom of yore is explored in depth scientifically for the lasting benefit of posterity. The establishment of a School of Tribal Resource Management is a step in this direction. The School has introduced three innovative interdisciplinary programmes namely Commerce, Economics and Geography, with specialization in Tribal Resource Management in the first phase with the approval of UGC to provide impetus to research in tribal resource management, tribal culture and tribal technology development. Besides implementing the Sustainable Development Goals of the United Nations, the School has succeeded in bringing about the tangible socio-economic changes in the tribal hinterland of Odisha and neighbouring states.

Because of the School's commitment to helping tribal students develop their vocational, entrepreneurial and life skills, it strives to break the vicious circle of poverty and social isolation in which tribal communities find themselves trapped. The school also seeks to make tribal students aware that the people of their communities have a right to access varied indigenous resources and opportunities in order to live a self- sufficient, adequate and dignified life

DEPARTMENT OF RENEWABLE ENERGY

The Department of Renewable Energy, operating under the School of Tribal Resource Management at KISS Deemed to be University, Bhubaneswar, was established on 2024-25 is a specialized vocational unit dedicated to empowering indigenous youth through sustainable technical education. Aligned with the core mission of KISS, the department offers completely free, residential education to tribal students, explicitly focusing on bridging the socio-economic gap and creating self-reliant livelihoods in rural sectors. Rather than relying on traditional rote learning, the department utilizes the Bachelor of Vocation (B.Voc.) framework to deliver an industry-aligned education that blends academic theory with intense, hands-on skill development and on-the-job industrial training. Furthermore, the department uniquely leverages the massive, eco-friendly KISS campus infrastructure—which runs on utility-scale solar arrays and mega biogas plants—as a live, operational laboratory. Ultimately, the department focuses on producing day-one ready technical professionals, project supervisors, and green entrepreneurs equipped to deploy clean energy solutions directly within remote, off-grid tribal communities. B.Voc. courses offer Bachelor of Vocational Degree options across various fields for students who have completed their foundational education. (10+2/ ITI).These programs integrate specific job roles and NOSs with a comprehensive general education curriculum. The primary goal is to enhance the employability prospects of individuals, facilitating their ability to learn, earn, and progress.

Vision & Mission of the School

Vision

Emerge as an internationally acclaimed School recognized for excellence in teaching, research, consultancy, outreach, skill development, and social entrepreneurship, while promoting cultural heritage and diversity.

Mission

- Foster all-round development through multi-faceted education.
- Focus on sustainable resource management through innovative courses.
- Engage with communities to promote entrepreneurship and leadership.
- Manage resources effectively to create employment and self-employment opportunities.

Programme Overview

Programme Title:B Voc- Renewable Energy

Programme Type: Undergraduate

Programme Description

The Department of Renewable Energy, operating under the School of Tribal Resource Management at KISS Deemed to be University, Bhubaneswar, is a specialized vocational unit dedicated to empowering indigenous youth through sustainable technical education. Aligned with the core mission of KISS, the department offers completely free, residential education to tribal students, explicitly focusing on bridging the socio-economic gap and creating

self-reliant livelihoods in rural sectors.

Process of Curriculum Development

All Schools shall follow the standard KISS-DU curriculum development protocol:

1. Formation of Syllabus Committee with domain experts.
2. Consultation with stakeholders (students, alumni, employers, community).
3. Review and approval by School faculty.
4. Vetting by Board of Studies (BoS) with external experts.
5. Final approval by the Academic Council.
6. Integration of NEP-2020, CBCS, NCrF, and NHEQF guidelines.

Definitions of Components

a) Ability Enhancement Courses (AEC): It refers to the courses enhancing competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills not literature, prose, poetry and novel etc.

b) Academic Bank of Credits (ABC): The ABC has been envisaged by the UGC to facilitate the academic mobility of students with the freedom to study across the HEIs in the country with an appropriate 'credit transfer' mechanism from one programme to another, leading to attain a Degree/Diploma/Certificate, etc.

c) Academic Year: Two consecutive semesters constitute one academic year.

d) Choice Based : The students select courses from the prescribed courses i.e., Major, Minor, Multidisciplinary, Ability Enhancement Course (AEC), Skill Enhancement Course (SEC), Value Added Course (VAC), Summer Internship/ Lab/Research.

e) Major is the subject of main focus.

f) Credit Based Semester System (CBSS): Under the CBSS, the requirement for awarding a degree/diploma/Certificate is prescribed in terms of the number of credits to be earned.

g) Credit: A unit by which the course work is measured. One credit is equivalent to one hour of lecture or tutorials or two hours of practical work/field work per week in a semester.

h) Minor Course helps a student to gain a broader understanding beyond the major discipline. The subjects mentioned in the minor (in the course structure table) will be offered only if a minimum of 10 students opt for that particular subject.

i) Multidisciplinary: It refers to the courses that a student can opt from other disciplines in order to broaden the intellectual experience.

j) Skills Enhancement Courses (SEC): It refers to the courses aiming at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students.

k) Summer Internship/Apprenticeship/Summer Project: It refers to experiential exposure of a student. Summer Internship of 6-8 weeks duration after the completion of the fourth semester, followed by a project report and viva-voce examination during the fifth semester has been made compulsory to enable the students to have hands-on experience of real-life business situations.

l) Research has been provided in the Eighth semester (for students securing 7.5 CGPA or above) involving application of knowledge in exploring/critical analysis/solving issues related to a real-life situation.

m) Value Added Courses: It refers to the courses enabling the students to acquire and demonstrate the knowledge and understanding of contemporary society.

n) Skills Courses:- This course is only offer by BVoc Programme, helps the student to develop themselves in skill education in core branches like Renewable Energy, Farming and Entrepreneurship.

COURSES OF STUDY

1. SKILL DEVELOPMENT COMPONENTS

a) To equip students with appropriate knowledge, practice and attitude, so as to become work ready.
b) To be embedded within itself, National Occupational Standards (NOSs) of specific job roles within the industry sectors.
c) It will lead to comprehensive specialization in one or two domains.
d) Focuses on work readiness skills.
e) At least 50% of Skill Development Component should be allotted to practical and can grow up to 60% based on the nature of the course. The practical component can be carried out in the college and/or the industry partner premises.

f) Designed to focus on practical work, on the job training, development of student portfolios and project work.

2. GENERAL EDUCATION COMPONENT

a) The general education component provides emphasis to Communication skill, Presentation skill, Industrial Psychology, Environmental awareness, Entrepreneurship development and other relevant subjects in the field.
b) An option for additional language should be provided which enhances the employability outside the state.
c) To adhere to normal university standards, that should not exceed to 40% of the total course of study.
d) All B.VOC Programmed should follow the General education component pattern listed below (Common English Courses and Additional language courses of LRP programs of KISS DU)

NCrF-Aligned Components (National Credit Framework)

1. Operational Definition of Credit (NCrF Standard)
"1 Credit = 30 Notional Learning Hours."
A standard 4-credit course = 120 Notional Learning Hours.
NCrF-Compliant Course Engagement Table

Component	Operational Definition	Hours (Example for 4-credit course)
Face-to-Face Lectures	Concept delivery, interactive instruction	45
Tutorials / Labs / Field	Hands-on practice, experimentation	30
Independent Self-Study	Pre-reading, journal review	20
Continuous Assessment	Assignments, quizzes,mid-term	12
Final Semester Exam Preparation	Revision, project completion	13
Total Notional Hours	Must equal 30 hours × credits	120

MOOC Courses (SWAYAM and SWAYAM Plus)
According to the UGC guidelines integrated into the new curriculum structures, Higher Education Institutions (HEIs) are permitted to allow students to take up to 40% of their total courses in a semester through the national MOOC platform, SWAYAM (or SWAYAM Plus for industry-aligned courses).
Credits earned via SWAYAM are mapped directly against the appropriate NHEQF academic level and digitally stored in the student's Academic Bank of Credits (ABC) to count toward their final degree, diploma, or certificate.

NCrF Category Wise Credit Distribution (UGC CCFUP Compatible) (for UG Programme)

Semester	Discipline Specific courses- core		Minor		MDC/IDC		AEC		SEC/ Internship/Dissertation		VAC		Grand Total Credits
	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credit	
I	4	12	0	0	1	3	1	2	-	-	1	4	21
II	4	12	0	0	1	3	1	2	-	-	2	4	21
III	4	12	0	0	1	3	1	2	1	3	-	-	20
IV	4	15	0	0	1	3	1	2	-	-	-	-	20
V	4	16	0	0	-	-	-	-	1	4	-	-	20

VI	5	17	0	0	-	-	-	-	1	3	-	-	20
VII	0	0	0	0	-	-	-	-	1	20	-	-	20
VIII	4	16	0	0	-	-	-	-	1	4	-	-	20
Total Credits for the Course	29	100	0	0	4	12	4	8	5	34	3	8	162

These exit awards correspond to progressive NHEQF / NSQF levels and are fully NCrF-compliant for credit accumulation, mobility and re-entry through the Academic Bank of Credits.
Skill Enhancement Courses (SEC), Multidisciplinary Courses (MDC), value-added courses and internships are creditised as per NCrF, recognising vocational, experiential and community-based learning alongside academic coursework. These courses are designed at appropriate NSQF levels, with clear competency descriptors and notional hours.

vii. Eligibility for Admissions with No. of Seats

As per the admission guidelines and brochure of the KISS Deemed to be University.

viii. Examination Pattern for UG as per NEP 2020

The medium of examination is English which will be reflected in their final grade sheet/certificate. Provided that for a language subject answers are to be in that language. Sanskrit may be written in Odia script but language has to be Sanskrit.

Duration of the Examinations-Mid Semester & End Semester:

Duration of examination for all term End examination shall be for 2.5 hours and for all Mid Term examination for 1 hour irrespective of full marks in the course/subjects and irrespective of credit. The practical examinations shall be of 2 hours duration.

Each School shall have a designated faculty as Examination Coordinator to be decided by the Vice Chancellor in addition to the Controller of Examinations of the University.

Continuous Evaluation and Mid Semester Examination:

a) Mid semester examination will be of 1-hour duration for 20/10 marks (20 for subjects having no practical and 10 for subject with practical papers). There shall be no pass mark in Mid Semester examination.
b) The Mid-Semester Examination shall be conducted and valued by the Faculty who are teaching the corresponding paper. A student who fails to appear in a Mid-Semester Examination **will be allowed one more chance to** take the same examination before appearing the concerned term-end examination. There will be no provision to re-appear in the Mid-Semester Examination for improvement.
c) For subjects with practical there will be a Mid-Semester practical examination carrying 10 marks.
d) The University authority of the valuation zones will preserve the answer Script of the End Semester examination for 06 months from the date of publication of result for reference.
e) A student has to appear the mid semester examination positively. Absence in the mid semester examination will be considered as fail however the candidate may be allowed to appear the mid semester examination before commencement of the concerned Term-End examination under special case duly considered by the HoD (for the ***candidates who represent the University or State for Inter-University or inter-state competitions in Games and Sports or attending different recognized National level camps/any critical medical case duly certified by the designated medical officer).***

Distribution of Marks in End Semester and Continuous Evaluation:
(Irrespective of credit in a course/Paper)

Course Type	Maximum Marks	Semester- End theory Mark	Continues Evaluation Marks /Sessional	Mid Semester theory Mark	Semester-End and Practical mark	Mid Semester Practical Mark
Without Practical	**100**	**60**	**20**	**20**	**----**	**--**
With Practical	**100**	**50**	**10**	**10**	**20**	**10**
Thesis/ Dissertation/ Seminar/Field Work	**100**	**------**	**-------**	**-------**	**-------**	**-------**

The **modes of evaluation** of **Thesis/ Dissertation/ Seminar/Field Work** shall be as follows:
Selection of Research Topic and Synopsis Presentation
Literature Review and Preparation of Research Tools (Questionnaires and schedule)
Fieldwork and Data Collection
Data Analysis and Report Writing
Seminar Presentation and Viva voce test on dissertation

Distribution of Sessional Marks:(Continuous Evaluation)

Course Type	Maximum Mark	Mid Semester	Attendance	Surprise Test/Quiz/Viva	Assignment/ Presentation
Without Practical	**40**	**20**	**Above 95%- 5 Marks** **85%-94%- 4 Marks** **75%-84%- 3 Marks**	**10**	**05**
With Practical	**30**	(Theory 10 + Practical 10)=20		**05**	**Nil**

Examination Question Pattern of End Term Examination and Mark Distribution:

The evaluation process may cover summative and formative aspects and assess understanding applications, articulation, program and course outcome.

Question Pattern		With Practical	Without Practical
Part-I –Objective	**Answer in MCQ/ in one word/in one sentence as directed**	**1x5=5**	**1x6=6**
Part-II- Very Short Type	**Answer within 50 words. Answer any 3 out of 5 questions (with practical) and Answer any 5 out of 7 question (without practical)**	**2x3=6**	**2x5=10**

Part-III- Short Type	**Answer within 250 words Answer any 3 out of 5 questions (with practical) and Answer any 4 out of 6 question (without practical)**	**5x3=15**	**5x4=20**
Part-IV- Long Type	**Answer within 800 words. Answer any 3 out of 5 questions**	**8x3=24**	**8x3=24**
Total		**50**	**60**
For Practical Paper		**One Major Experiment-10 Record- 05 Viva voce-05**	**---------**

Examination Question Pattern of Mid Semester Examination and Mark Distribution

Question Pattern		**With Practical**	**Without Practical**
Part-I –Objective	**Answer in MCQ/ in one word/in one sentence as directed**	**1x3=3**	**1x6=6**
Part-II- Very Short Type	**Answer within 50 words. Answer any 1out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)**	**2x1=2**	**2x2=4**
Part-III- Short Type	**Answer within 250 words Answer any 1 out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)**	**5x1=5**	**5x2=10**
Total		**10**	**20**
For Practical Paper		**One Major Experiment-5 Record- 02 Viva voce-03**	**---------**

Award of Degree:A Degree certificate under the official seal of the university and signed by the Vice-Chancellor shall be presented at the Convocation or in absentia to each of the successful students of particular degree. The Controller of Examinations shall issue the mark/grade sheet of each semester to the candidates in the sheet of each semester to the candidates in the prescribed format.

XI. Attendance Requirement

Attendance in Lecturer, tutorials, seminars etc. arranged by the school from time to time, is mandatory according to the Internal Assessment requirement as per University rules.

The marks for attendance shall be as follows		
(i)	For 75%	1 Marks
(ii)	More than 75% but less than 80%	2 Marks
(iii)	80% or more but less than 85%	3 Marks
(iv)	85% or more but less than 90%	4 Marks
(v)	90% and above	5 Marks

XII. Duration and Types of Courses and Process of Multiple Entry and Exit

NHEQF-Aligned Components (National Higher Education Qualifications Framework)

1. NHEQF Level Mapping for Multi-Entry / Multi-Exit

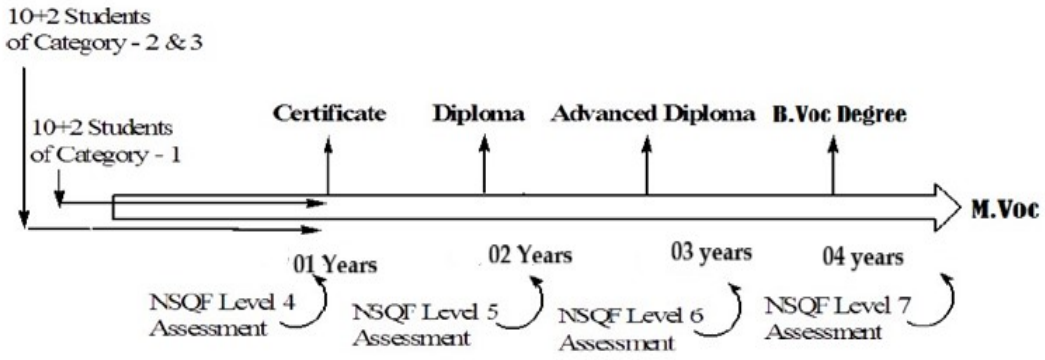
"This programme is structured according to the multi-entry, multi-exit parameters defined by UGC. The progressive qualification bands map directly onto the National Higher Education Qualifications Framework (NHEQF)."

Milestone / Year Completed	Exit Award	NHEQF Level	Standard Credit Range
Year 1 (Sem I–II)	UG Certificate	Level 4.5	~40 + 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.
Year 2 (Sem III–IV)	UG Diploma	Level 5.0	~80 + 4 credit in skill based vocational courses offered during first year or second year summer term
Year 3 (Sem V–VI)	UG Degree (3-Year)	Level 5.5	~120
Year 4 (Sem VII–VIII) Year 1(Sem I-II)	UG Honours / Honours with Research Post-Graduate Diploma	Level 6.0	~160
Year 2(Sem III-V)	Master's degree (e.g. M.A., M.Com., M.Sc., etc.)	Level 6.5	80 Credits
	Doctoral Degree	Level 8.0	Credits for coursework and, a thesis and published work

LEVELS OF AWARDS

The certification levels will lead to Diploma/ Advanced Diploma/ B.Voc. Degree in one or more vocational areas and will be offered under the aegis of the University.

Award	Duration	Corresponding NSQF level
Certificate	1 Year	4
Diploma	2 Years	5
Advanced Diploma	3 Years	6
B.VOC Degree	4 Years	7



1. Students are free to exit at any point in the duration of the programme.
2. Only those students who successfully complete the courses and clear the examination are eligible for the certificate.
3. Separate certificate will be awarded for each year for successful candidates.
4. Students who fail in any course may be allowed to move the higher level but won't be eligible for any certificates until he/she clears previous courses.
5. B. VOC degree will confer to those whose successfully complete the diploma, higher diploma and internship.

GENERAL PROGRAMME STRUCTURE

The B. VOC Programme is designed to bridge the potential skill gap identified. The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components.

CONDITIONS FOR ADMISSIONS ELIGIBILITY

1. The admission to B.VOC programme will be as per the rules and regulations of the University for UG admissions.
2. Basic eligibility or B.VOC is 10+2 and above in any stream (No age limit)
3. The eligibility criteria for admission shall be as announced by the University from time to time
4. Separate rank lists shall be drawn up for reserved seats as per the existing rules.
5. Grace marks may be awarded to a student for meritorious achievements in co-curricular activities such as Sports/ Arts/ NSS/ NCC/ Student Entrepreneurship.
6. Preferred subjects and index mark calculations will be decided by the respective Boards of Studies.

DESIGN OF COURSES OF STUDY AS PER B.VOC. GUIDELINE:

Level	Process required	Professional knowledge	Professional skill	Core skill	Responsibility
Level 5	Job that requires well developed skill, with clear choice of procedures in familiar context	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools materials and information	Desired mathematical skill, understanding of social, political and some skill of collecting and organizing information, communication	Responsibility for own work and learning and some responsibility for other's works and learning
Level 6	Demands wide range of specialized Technical skill, clarity of knowledge and practice in broad range of activity involving standard /non-standard practices	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of Cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Reasonably good in mathematical calculation, understanding of social, political and, reasonably good in data collecting organizing information, and logical communication	Responsibility for own work and learning and full responsibility for other's works and learning

Level 7	Requires a command of wide ranging specialized theoretical and practical skill, involving variable routine and non-routine context	Wide ranging, factual and theoretical knowledge in broad contexts within a field of work or study	Wide ranging, factual and theoretical knowledge in broad contexts within a field of work or study	Good logical and Mathematical skill understanding of social political and natural environment good in collecting and organizing information, communication and presentation skill	Full responsibilit y for output of group and developmen t

Programme Educational Objectives (PEO)

PEO1: Enable students to build successful careers in public/private sectors, entrepreneurship, or community development.
PEO2: Promote interdisciplinary and multidisciplinary learning and research.
PEO3: Develop entrepreneurial, analytical, and problem-solving skills.
PEO4: Prepare students for higher education, professional certifications, and research.
PEO5: Foster lifelong learning, ethical conduct, and social responsibility.

PROGRAMME OBJECTIVES (POs):

PO1	**Moral and Ethical Values:**	Apply ethical values, social responsibility, and sustainable practices in energy generation and utilization.
PO2	**Domain Knowledge:**	Apply principles of science, engineering, and renewable energy technologies to solve energy-related problems.
PO3	**Technical Skills:**	Demonstrate practical skills in installation, operation, testing, and maintenance of renewable energy systems.
PO4	**Problem Analysis & Critical Thinking:**	Identify, analyze, and solve technical and operational problems in renewable and conventional energy applications.
PO5	**Indian Knowledge System:**	Apply Indian traditional knowledge, ecological wisdom, and sustainable practices in renewable energy and resource management.
PO6	**Design & Development:**	Design, develop, and implement renewable energy projects using suitable methods and technologies.
PO7	**Modern Tool Usage:**	Use modern instruments, simulation software, digital tools, IoT, and AI for energy system monitoring and optimization.
PO8	**Entrepreneurship & Innovation:**	Develop entrepreneurial abilities and innovative ideas for renewable energy businesses and sustainable enterprises.
PO9	**Industry Readiness:**	Integrate theoretical knowledge with industrial practices through internships, field training, and project-based learning.
PO10	**Communication, Teamwork & Leadership:**	Communicate effectively and work efficiently as a team member or leader in multidisciplinary environments.
PO11	**Ethics & Sustainability:**	Practice professional ethics, environmental protection, energy conservation, and sustainable development approaches.
PO12	**Lifelong Learning:**	Engage in continuous learning and skill development to adapt to emerging technologies and industry trends.

PROGRAMME SPECIFIC OBJECTIVES (PSOs)

PSO1: Understanding of solar, wind, biomass, hydro and hybrid renewable energy systems.

PSO2: Ability to design, install, operate and maintain renewable energy systems.

PSO3: Competence to improve energy efficiency and propose sustainable solutions.

PSO4: Ability to use digital tools, simulation software, IOT and GIS in energy applications.

PSO5: Development of employability and entrepreneurship skills in the renewable energy sector.

CREDIT CALCULATIONS- B.VOC. :

a) One Credit would mean equivalent to 15 periods of 60 minutes each, for theory, workshops/ labs and tutorials.
b) For internship/ field work, the credit weightage for equivalent hours shall be 50% of that for lectures/ workshops.
c) For self-learning, based on e-content or otherwise, the credit weightage, for equivalent hours of study should be 50% or less of that for lectures/ workshops.

SUGGESTED CREDITS:

The following table shows the various certificates and their duration.

NSQF Level	Skill Component Credits	General Education Credits	Total credits for Awards	Normal calendar duration	Exit Points/ Awards
4 (Year 1)	24	18	42	Two Semester	Certificate
5 (Year 2)	54	28	82	Four Semesters	Diploma
6 (Year 3)	87	35	122	Six Semesters	Advanced Diploma
7 (Year 4)	127	35	162	Eight Semesters	B.VOC Degree

Course Structure for Renewable Energy

Duration: 4 Years No. of Semesters: 8
No. of Credits per Semester: 20 Total Credits for the Course: 162
No. Credits for General Component in each Semester: ≤9
No. Credits for Skill Component in each Semester: ≥11

SEMESTER-I

Course Category		Course Code	Course Title	Credits			
				L	T	P	Total Credits
Skill Components	Skill Course (Core Course)	BR10001	Fundamentals of Electrical and Electronics system	2	0	1	3
		BR10003	Energy Sources and Energy Scenario	2	1	0	3
		BR10005	Fundamental of Solar PV Power System	2	0	1	3
		BR10007	Hydro Electric energy system	2	1	0	3
General Components	Multidisciplinary (MDC)	CC13001	Financial Literacy	2	1	0	3
	Ability Enhancement Course (AEC) (Choose any One)	AE14001	Modern Indian Language (Odia)	2	0	0	2
		AE14003	Modern Indian Language (Hindi)	2	0	0	2
		AE14005	Modern Indian Language (Sanskrit)	2	0	0	2
		AE14007	Modern Indian Language (Santali)	2	0	0	2
		AE14009	Alternative English	2	0	0	2
	Value Added Course (VAC)	VA16201	Environment Education and Disaster Management	3	0	1	4
%age of Components		**Total**		**15**	**3**	**3**	**21**
	Skill Components	**12**		**57%**			
	General Components	**9**		**43%**			

SEMESTER-II

Course Category		Course Code	Course Title	Credits			
				L	T	P	Total Credits
Skill Components	Skill Course (Core Course)	BR10002	Introduction to Fundamental of Power Electronics	**2**	**1**	**0**	**3**
		BR10004	Biomass Power Generation Systems	**2**	**1**	**0**	**3**
		BR10006	Roof-top Solar PV Installation	**2**	**0**	**1**	**3**
		BR10008	Electrical Systems	**2**	**0**	**1**	**3**
General Components	Multidisciplinary Course (or any other course from Arts or Science stream offered by the University)	CS13002	Data Analytics	**2**	**1**	**0**	**3**
	Ability Enhancement Course (AEC)	AE14002	Translation Studies (Odia)	2	0	0	2
		AE14004	Translation Studies (Hindi)	**2**	0	0	**2**
		AE14006	Translation Studies (Sanskrit)	**2**	0	0	**2**
		AE14008	Translation Studies (Santali)	**2**	0	0	**2**
		AE14010	Translation Studies (English)	**2**	0	0	**2**
	Value Added Course (VAC)	VA16124	Enhancement of Active Citizenship and Democratic Values	**2**	**0**	**0**	**2**
		VA16134	Inclusive Education and Gender Equality	**2**	**0**	**0**	**2**

		VA16142	Combating Radicalism through Education	**2**	**0**	**0**	**2**
		VA16146	Indian Knowledge System	**2**	**0**	**0**	**2**
		VA16394	Flutter Application Development	**1**	**0**	**1**	**2**
		VA16422	Human Values and Professional Ethics	**2**	**0**	**0**	**2**
		VA16430	Life Skills Education	**2**	**0**	**0**	**2**
		VA16482	Self-help and Happiness	**2**	**0**	**0**	**2**
		VA16484	Community Engagement and Social Responsibility	**2**	**0**	**0**	**2**
		VA16486	Pioneering Service Learning and Community Development	**2**	**0**	**0**	**2**
		VA16488	Sports and Yoga	**2**	**0**	**0**	**2**
			Total	**14**	**4**	**3**	**21**
% age of Components	**Skill Components**		**12**	**57%**			
	GeneralComponents		**9**	**43%**			

Exit Point: Undergraduate Certificate

Students exiting the program after securing 40 credits will be awarded a UG Certificate in Renewable Energy, provided they secure 4 credits in work-based vocational courses offered during the summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semester.

SEMESTER-III

Course Category		**Course Code**	**Course Title**	**Credits**			
				L	**T**	**P**	**Total Credits**
Skill Components	Skill Course (Core Course)	BR20001	Wind Energy	3	0	1	4
		BR20003	Electrical Measurement and Electronic Instruments	3	0	0	3
		BR20005	Advanced Renewable Energy Sources	2	1	0	3
		BR20007	Practical Implementation to Arduino UNO	1	0	1	2
General Components	Multidisciplinary (MDC)	CS23001	Introduction to Artificial Intelligent and Machine Learning	2	1	0	3
	Ability Enhancement Course (AEC) (Choose any One)	AE24001	Communicative English	2	0	0	2
	Skill Enhancement Course (SEC)	EC25001	Elementary Computer Application in Presentation of Data	2	0	1	3
			Total	**15**	**2**	**3**	**20**
%age of Components	**Skill Components**		**12**	**60%**			
	General Components		**8**	**40%**			

SEMESTER-IV

Course Category		Course Code	Course Title	**Credits**			
				L	**T**	**P**	**Total Credits**
Skill Components	Skill Course (Core Course)	BR20002	Energy Storage Systems	3	1	0	4
		BR20004	Sensors and its application	3	1	0	4
		BR20006	Energy Conservation Techniques	3	0	1	4
		BR20008	Introduction to Electric and Hybrid Electric Vehicle	3	0	0	3
General Components	Multidisciplinary (MDC)	BN20010	Introduction to Python Programming	2	0	1	3
	Ability Enhancement Course(AEC)	AE24002	Professional Communication	2	0	0	2
			Total	**16**	**2**	**2**	**20**
% age of Components	**Skill Components**		**15**	**75%**			
	General Components		**5**	**25%**			

Exit Point: Undergraduate Certificate

Students exiting the programmed after securing 80 credits will be awarded a UG in Renewable Energy provided they secure an additional 4 credits in skill-based vocational courses offered during the first year or second year summer term.

Approved by: -

Chairman Council of Dean	Dean School of Tribal Resource Management	Faculty Coordinator	Expert 1	Expert 2

SEMESTER-V

Course Category		Course Code	Course Title	Credits			
				L	**T**	**P**	**Total Credits**
Skill Components	Skill Course (Core Course)	BR30001	Distributed Generation Systems	3	1	0	4
		BR30003	Electric Vehicle Management System	3	1	0	4
		BR30005	D.C. Machines and Transformer	3	0	1	4
		BR30007	Hydrogen Energy and Fuel Cell	3	1	0	4
General Components	Skill Enhancement Course (SEC)	BR35001	Mechatronics and Robotics	3	1	0	4
			Total	15	4	1	20
%age of Components	**Skill Components**		**16**	**80%**			
	General Components		**4**	**20%**			

SEMESTER-VI

Course Category		Course Code	Course Title	Credits			
				L	**T**	**P**	**Total Credits**
	Skill Course (Core Course)	BR30002	Introduction to Power system	3	1	0	4
		BR30004	Introduction to Control System	3	0	1	4
		BR30006	Microprocessor and Micro-controller with Interfacing: Industry Collaboration	2	1	0	3
		BR30008	IoT-Based Real-Time Solar PV Monitoring System	3	0	0	3
		BR30010	Electrical CAD Software	1	0	1	2
	Skill Enhancement Course (SEC)	BV35002	Research Design and Scientific Writing	3	0	1	4
			Total	15	2	3	20
%age of	**Skill**	**17**	**85%**				

Components	**Components**		
	General Components	**3**	**15%**

Exit Point: Undergraduate Certificate

Students exiting the program after securing 120 credits will be awarded a UG in Renewable Energy provided they secure an additional 4 credits in skill-based vocational courses offered during the first year or second year summer term.

SEMESTER-VII

Course Category		Course Code	Course Title	**Credits**			
				L	**T**	**P**	**Total Credits**
Skill Components	Skill Course (Core Course)	IP40081	Industrial Internship	0	0	20	20
			Total	0	0	20	20
%age of Components	**Skill Components**		**20**	**100%**			
	General Components		**0**	**0%**			

SEMESTER-VIII

Course Category		Course Code	Course Title	**Total Credits**			
				L	**T**	**P**	**Credits**
Skill Components	Skill Course (Core Course)	BR40002	Introduction to Switchgear and Protection	2	0	0	2
		BR40004	Energy Management and Auditing	2	0	0	2
		BR40006	Smart Electric Grid	2	0	0	2
		BR40008	Environmental Impact Assessment (EIA) Waste to Energy Conversions	2	0	0	2
		RD40082	Research and Dissertation	0	0	12	12
			Total	8	0	12	20
%age of Components	**Skill Components**		**20**	**100%**			
	General Components		**0**	**0%**			

Exit Point: Undergraduate Certificate

Students exiting the programmed after securing 162 credits will be awarded a UG in Renewable Energy provided they secure an additional 4 credits in skill-based vocational courses offered during the first year or second year summer term

Approved by: -

Chairman Council of Dean	Dean School of Tribal Resource Management	Faculty Coordinator	Expert 1	Expert 2

SEMESTER 1

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10001	Fundamentals of Electrical and Electronics system	2	0	1	3

Prerequisite: Students should possess basic knowledge of Physics and Mathematics at the 10+2 level, including concepts of current, voltage, resistance, power, basic algebra, and unit conversions. Familiarity with elementary electrical appliances, safety practices, and scientific calculations will help students understand electrical circuits and electronic components more effectively.

Course Objective:

To provide fundamental knowledge of electrical and electronic engineering concepts, including DC/AC circuits, safety, and wiring. The course also develops skills in analyzing circuits and understanding the operation of basic electronic devices for practical applications.

CO1: Explain the fundamental electrical engineering concepts, laws, and measuring instruments.
CO2: Analyze and solve DC circuits with resistors, capacitors, and inductors while applying electrical safety practices.
CO3: Apply AC circuit principles to determine power factor, RMS/average values, and perform basic power system wiring analysis.
CO4: Demonstrate the working of basic semiconductor devices and amplifiers.
CO5: Evaluate the simple electronic applications of logic circuits.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	1	3	2	2	-	-	-	-	1	-	2	2	3	2	-	-	-
CO2	2	3	-	2	2	-	-	-	1	-	2	-	2	3	-	-	-
CO3	-	3	-	3	3	2	-	-	2	-	2	-	2	2	-	3	-
CO4	1	3	-	2	3	-	-	-	1	-	2	-	2	3	2	2	-
CO5	-	3	-	3	3	2	-	-	1	-	2	2	2	2	2	3	2
CO6	1	3	2	3	3	3	-	-	2	-	3	3	3	3	3	2	2
avg	0.79	3	0.66	2.5	2.33	1.16	-	-	1.6	-	2.16	1.16	2.33	2.5	1.16	1.66	0.66

Course Contents

Unit 1: Basic Electrical Engineering Concepts (10 Hours)

Introduction to Electrical Engineering, Electrical Quantities: Voltage, Current, Resistance, Power, Ohm's Law, Kirchhoff's Laws, Series and Parallel Circuits and Measurement Instruments: Voltmeter, Ammeter, Multimeter

Unit 2: DC Circuits & Safety Equipment (8 Hours)

Resistors, Capacitors, Inductors in DC Circuits, Electrical Safety & Protection Devices (Fuses, MCB, ELCB)

Unit 3: AC Circuits and Power System wiring (10 Hours)

Alternating Current (AC) and AC Waveforms, RMS and Average Value, Power Factor, AC Circuit Analysis (RLC Circuits) and Basics of Domestic & Industrial Wiring

Unit 4: Electronic Devices and Circuits (12 Hours)

Introduction to Semiconductors (Diodes, Transistors), Rectifiers and Power Supplies, Bipolar Junction Transistors (BJTs) and Field-Effect Transistors (FETs), Operational Amplifiers and Applications and Basics of Digital Electronics (Logic Gates, Boolean Algebra).

Text Books

Principles of Electrical and Electronics Engineering – V. K. Mehta & Rohit Mehta, S. Chand

Reference Books

Basic Electrical Engineering – D. P. Kothari & I. J. Nagrath, Tata McGraw Hill

Fundamentals of Electrical Engineering – Rajendra Prasad, PHI Learning
Basic Electrical and Electronics Engineering – S. K. Bhattacharya, Pearson
Electrical and Electronics Engineering – Ritu Sahdev, Cambridge University Press
Electronics Devices and Circuit Theory – Robert L. Boylestad & Louis Nashelsky, Pearson
Electronic Principles – Albert Paul Malvino & David J. Bates, McGraw Hill

Practical

1. To find the equivalent resistance of two resistances in series connection.
2. To find the equivalent resistance of two resistances in parallel connection
3. Study of Resistor Colour Coding.
4. Study of House Wiring Practice.
5. Study of Circuit Troubleshooting.

https://www.vlab.co.in/Virtual Labs

SDG Mapping

SDG	Title	Contribution
4	Quality Education	Builds foundational electrical and electronics knowledge
7	Affordable and Clean Energy	Understanding efficient electrical systems and renewable integration
8	Decent Work and Economic Growth	Develops technical employ ability skills
9	Industry, Innovation and Infrastructure	Supports electrical and electronic technology applications
12	Responsible Consumption and Production	Promotes safe and efficient energy utilization

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10003	Energy Sources and Energy Scenario	2	1	0	3

Prerequisite: Students should have a general understanding of science, environment, and natural resources from secondary education. Basic awareness regarding electricity consumption, fossil fuels, renewable resources, climate change, and sustainable development concepts is desirable.

Course Objective: -To provide fundamental knowledge of energy, its sources, conversion, and applications. To develop an understanding of sustainable energy policies and technologies for future needs.

Course Outcomes (COs)

CO1: Identify different forms, sources, and units of energy.

CO2: Understand the Energy units and conversion factors.

CO3: Apply the principles of conventional and renewable energy systems in real-world contexts.

CO4: Analyze the efficiency, impacts, and challenges of various energy technologies.

CO5: Evaluate energy policies, sustainability measures, and strategies for conservation.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	1	3	2	2	-	-	-	-	2	-	-	2	2	1	2	-	-
CO2	-	3	2	2	2	-	-	-	-	-	-	-	2	1	2	-	-
CO3	2	3	2	3	3	-	-	-	2	-	2	3	3	3	3	2	-
CO4	1	3		3	3	2	-	-	-	-	2	3	2	3	3	2	-
CO5	3	2	2	3	2	2	-	-	2	2	3	3	2	2	3	3	3
Avg.	1.75	2.8	2	2.6	2.5	2	-	-	2	2	2.33	2.75	2.2	2	2.6	2.33	3

Course Contents

Unit 1: Introduction to Energy and Its Importance (11 Hours)

Definition and Forms of Energy, Primary and Secondary Energy Sources, Renewable vs. Non-Renewable Energy, Global and Indian Energy Demand & Supply, Energy Units and Conversion Factors

Unit 2: Conventional Energy Sources (10 Hours)

Fossil Fuels: Coal, Oil, and Natural Gas, Nuclear Energy: Fission and Fusion Processes, Hydro-power: Basic Knowledge of Hydro-power plant and Environmental Impacts, Thermal Power Plants: Working and Efficiency and Energy Crisis and Conservation Strategies

Unit 3: Renewable Energy Sources (10 Hours)

Introduction to Solar Energy: Photovoltaic and Thermal Applications, Introduction to Wind Energy: Wind Turbines and Power Generation, Introduction to Biomass Energy: Biogas, Biofuels, and Waste-to-Energy, Geothermal and Introduction to Ocean Energy: Tidal and Wave Energy

Unit 4: Energy Policies and Sustainability (9 Hours)

National and International Energy Policies, Sustainable Development and Green Energy Transition, Energy Audits and Management, Case Studies on Renewable Energy Projects

Text Books

Renewable Energy Sources and Emerging Technologies – D.P. Kothari, K.C. Singal & Rakesh Ranjan, *PHI Learning*

Reference Books

1. Energy Engineering and Management – Amlan Chakrabarti, *Prentice Hall India*
2. Non-Conventional Energy Sources – G.D. Rai, *Khanna Publishers*
3. Renewable Energy: Power for a Sustainable Future – Godfrey Boyle, *Oxford University Press*
4. Solar Energy: Principles of Thermal Collection and Storage – S.P. Sukhatme & J.K. Nayak, *Tata McGraw Hill*
5. Wind Energy Explained: Theory, Design and Application – James F. Manwell, Jon G. McGowan & Anthony L. Rogers, *Wiley*
6. Biomass to Renewable Energy Processes – Jay Cheng, *CRC Press*

SDG Mapping

SDG	Title	Contribution
6	Clean Water and Sanitation	Sustainable water resource utilization
7	Affordable and Clean Energy	Hydropower generation systems
9	Industry, Innovation and Infrastructure	Hydro plant technologies and grid integration
11	Sustainable Cities and Communities	Reliable renewable electricity supply
13	Climate Action	Clean hydropower reducing greenhouse gas emissions

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10005	Fundamental of Solar PV Power System	2	0	1	3

Prerequisite: Students should have basic understanding of elementary electrical concepts such as voltage, current, power, and simple circuits along with basic physics concepts related to light, energy, and electricity. Prior exposure to renewable energy concepts will be beneficial but not mandatory.

Course Objectives:

This course introduces the fundamentals of energy, its sources, and utilization, with a focus on sustainability.
It equips students with knowledge of conventional and renewable systems, policies, and strategies for efficient energy management.

Course Outcomes (Cos):

CO1: Explain solar energy, PV technology, and PV systems.
CO2: Identify solar PV components and their functions.
CO3: Analyze solar cell and PV Unit parameters.
CO4: Apply PV Unit connections for system design.
CO5: Evaluate MPPT, charge controllers, and converters.
CO6: Design basic solar PV systems with proper sizing and safety

CO-PO-PSO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	2	3	2	2	-	-	-		-	-	2	2	3	2	-	-	-
CO2	1	3	-	2	2	-	-	-	-	-	2	-	2	3	-	-	-
CO3	-	3	-	3	3	2	1	-	-	-	2	-	2	2	-	3	-
CO4	1	3	-	2	3	-	-	1	-	1	2	-	2	3	2	2	-
CO5	-	3	-	3	3	2	1	-	-	-	2	2	2	2	2	3	2
CO6	3	3	2	3	3	3	-	-	-	1	3	3	3	3	3	2	2
Avg	1.2	3	2	2.5	2.8	2.33	0.33	0.16	-	0.33	2.16	2.33	2.33	2.5	2.33	2.5	2

Course Contents

Unit 1: Introduction to Solar Energy & Photovoltaic Systems (10 Hours)

Basics of solar energy and its importance, Fundamentals of photovoltaic (PV) technology, Types of solar PV systems (grid-connected, off-grid, hybrid), Components of a solar PV system (Units, inverters, batteries, etc.) and Solar radiation and site selection considerations.

Unit 2: Solar PV System Components & Design (8 Hours)

Types of solar panels and their specifications, Inverters, charge controllers, and balance of system (BOS) components and Battery storage systems: types, selection, and maintenance.

Unit 3: Solar Cells , PV Units And Arrays (12 Hours)

Parameters of Solar Cells , Factors affecting Electricity generated from a Solar Cell , Solar PV Units–Ratings , Unit Parameters Factors Affecting Electricity Generated by a Solar PV Unit, Measuring Unit Parameters, Solar PV Unit Arrays - Connection of Units in Series, in Parallel and in Series and Parallel (Mixed Combination)

Unit 4: Charge Controller, MPPT And Inverters (10 Hours)

Need For Balance of System (BoS) , Power Converters and their efficiency , DC to AC Converters(Inverters) , DC to DC Converters , Charge Controllers, Maximum Power Point Tracking(MPPT), Types of Wires and Wire Sizing, Junction Box.

Text Book

Renewable Energy Engineering and Technology: Principles and Practice – S. Rao & Dr. B.B. Parulekar, Khanna Publishers

Reference Books

1. Solar Photovoltaic Technology Production: Basics, Technologies and Applications – Chetan Singh Solanki, PHI Learning Pvt. Ltd.
2. Photovoltaic Systems – James P. Dunlop, American Technical Publishers
3. Photovoltaic Systems Engineering – Roger A. Messenger & Jerry Ventre, CRC Press
4. Solar PV Power: A Global Perspective with Emphasis on the Indian Context – Chetan Singh Solanki, PHI Learning Pvt. Ltd.

PRACTICALS

1. Study of Identifying Components of Solar PV System
2. Study of safety Precautions in Solar Installation
3. Study and Understanding of Types of Solar Panel.
4. Study of Basic Site Survey for Solar Installation.
5. Study of Solar Panel Orientation & Tilt Angle.
6. Study of Basic DC Circuit Connection.
7. Study of Series & Parallel Connection of Solar Panels.

Link: https://renewablelab.niu.edu/experiments/solarPanel

SDG mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Fundamentals of solar photovoltaic systems
9	Industry, Innovation and Infrastructure	Solar technology applications
11	Sustainable Cities and Communities	Rooftop and decentralized solar systems
12	Responsible Consumption and Production	Efficient solar energy utilization
13	Climate Action	Promoting low-carbon energy solutions

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10007	Hydro Electric Energy System	2	1	0	3

Prerequisite: Students should possess foundational knowledge of renewable energy systems along with basic concepts of water flow, pressure, gravity, and mechanical energy conversion. Understanding of elementary environmental science and geography will support better comprehension of hydroelectric systems.

Course Objective:
To provide students with fundamental knowledge of hydro power systems, their components, and working principles. The course aims to develop skills in design, operation, maintenance, and grid integration of hydro power plants.

Course Outcome:
CO1: - State renewable energy.
CO2: Understand the fundamentals of hydro power principles and systems.
CO3: - Analyze the design and functioning of various hydro power plant components.
CO4: - Apply knowledge of hydro turbines, generators, and grid integration techniques for efficient power generation.
CO5: - Demonstrate competence in plant operation, maintenance, safety measures, and environmental considerations.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	3	1	2	1	-	-	-	2	-	-	2	3	1	2	-	-
CO2	-	3	-	2	2	-	-	-	-	-	2	2	3	2	2	-	-
CO3	-	3	-	3	3	2	-	-	-	-	2	-	3	3	2	2	-
CO4	-	3	--	3	3	2	-	2	-	-	3	-	2	3	3	3	2
CO5	2	2	-	2	2	2	2	-	3	2	2	3	2	3	3	2	2
Avg	0.8	2.8	0.2	2.4	2.2	1.2	0.4	0.4	1	0.4	2.8	1.4	2.6	2.4	2.4	1.2	0.8

Course Contents

Unit 1: Fundamentals of Hydro Power (11 Hours)

Introduction to Renewable Energy & Hydropower, Basics of Energy Conversion & Power Generation, Types of Hydro Power Plants (Run-of-River, Storage, Pumped Storage, etc.), Components of a Hydro Power System and Advantages & Challenges of Hydro Energy.

Unit 2: Hydro Power Plant Components & Design (9 Hours)

Reservoirs, Dams, and Spillways, Intake Structures & Penstocks, Turbines & Their Types (Pelton, Francis, Kaplan, etc.), Generators & Electrical Systems and Control & Automation in Hydro Plants.

Unit 3: Power Generation & Grid Integration (10 Hours)

Working Principles of Hydro Turbines, Load Management & Power Dispatch, Synchronization with the Grid, Power Factor & Frequency Control and Smart Grid & Digital Monitoring in Hydro Plants.

Unit 4: Operation, Maintenance & Safety (10 Hours)

Hydro Power Plant Operations & Control Systems, Routine Maintenance of Mechanical & Electrical Components, Troubleshooting & Fault Diagnosis, Safety Measures & Emergency Handling and Environmental & Ecological Considerations.

Text Books

1. Hydro Power Engineering – *M.M. Dandekar & K.N. Sharma*, Vikas Publishing House

Reference Books

1. Renewable Energy Engineering and Technology: Principles and Practice – *S.Rao & Dr. B.B. Parulekar*, Khanna Publishers
2. Water Power Engineering – *Dandekar & Sharma*, Vikas Publishing House
3. Hydropower Development – *C.V.J. Varma*, New Age International Publishers
4. Hydraulic Turbines and Hydropower Plants – *R.K. Rajput*, Laxmi Publication.
5. Renewable Energy Resources – *John Twidell & Tony Weir*, Routledge (Taylor & Francis)
6. Power Plant Engineering – *P.K. Nag*, McGraw Hill Education
7. Hydro Power Practice – *K. Subramanya*, Tata McGraw Hill
8. Small Hydro Power Systems – *B.H. Khan*, Tata McGraw Hill
9. Electrical Power Systems – *C.L. Wadhwa*, New Age International Publishers

SDG Mapping

SDG	Title	Contribution
6	Clean Water and Sanitation	Sustainable water resource utilization
7	Affordable and Clean Energy	Hydropower generation systems
9	Industry, Innovation and Infrastructure	Hydro plant technologies and grid integration
11	Sustainable Cities and Communities	Reliable renewable electricity supply
13	Climate Action	Clean hydropower reducing greenhouse gas emissions

Course title	Code	Credits			Total Credit
		Lecture	Tutorial	Practical	
Financial Literacy	CC13001	2	1	0	3

Course Objectives:

This course aims to provide students with essential knowledge and skills to effectively manage personal finances, make informed financial decisions, and plan for their financial future. Topics covered include budgeting, saving, investing, managing debt, understanding credit, and basic principles of financial planning.

Course Outcomes:

CO1-Understand the importance of financial literacy in personal and professional life.

CO2- Learn about credit scores, credit reports, and how credit works.

CO3- Learn strategies for saving and investing money.

CO4-Explore basic principles of financial tax planning for short-term and long-term goals.

CO5-Understand the different types of debt and strategies for managing debt responsibly.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	1	1	2	2	1	2	2	2	1	2	3	2	1	2	1

CO 2	3	3	2	2	2	2	1	2	2	2	2	2	3	3	2	2	1
CO 3	3	3	3	2	3	2	1	2	2	3	2	3	3	3	3	2	2
CO 4	3	3	2	2	2	3	2	3	2	2	2	3	3	3	3	3	2
CO 5	3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3

Course Inputs:

Unit-I: Financial Planning and Financial Products: Introduction to Saving, Time value of money, Management of spending and financial Discipline

Unit-II: Banking and Digital Payment: Banking product and services, Digitisation of financial transactions:Debitcards(ATM cards) and Credit Cards ,Net banking and UPI,Digitalwallets,Security and Precautions against Ponzi Schemes and online frauds

Unit-III: Investment Planning and management:Investment opportunity and financial products,Insurancep lanning ,life and non-life including medical insurance schemes

Unit-IV: Personal Tax:Introduction to basic tax structure in India for personal taxation,Aspects of Personal Tax planning,Exemptions and deductions for individuals,e-filling.

Unit-V: Managing Debt: Types of debt (e.g., credit cards, student loans, mortgages) Strategies for managing debt, Understanding interest rates and how they affect debt

Recommended Learning Resources

Textbooks:

1.Textbook: "Personal Finance for Dummies" by Eric Tyson
2.Online resources: Khan Academy, Investopedia, NerdWallet
3.Guest speakers: Financial planners, bankers, or representatives from local credit unions
4.Financial Literacy:Prof.(Dr.) Amit Kumar Singh,Taxmann’s Publication

SDG Mapping with SDG Title and Contribution:

SDG No.	SDG Title	Contribution of the Course
SDG 1	No Poverty	Promotes financial inclusion, savings, and better financial management for economic security.
SDG 4	Quality Education	Enhances financial awareness, practical literacy, and informed decision-making.

SDG 5	Gender Equality	Encourages women's financial literacy and equitable financial participation.
SDG 8	Decent Work and Economic Growth	Supports informed financial planning, savings, and productive economic participation.
SDG 10	Reduced Inequalities	Promotes inclusive access to financial knowledge and services.
SDG 12	Responsible Consumption and Production	Encourages responsible spending, saving, and consumption behaviour.
SDG 16	Peace, Justice and Strong Institutions	Strengthens financial awareness, transparency, and responsible financial conduct.

Ability Enhancement Course (Choose any One)	AE14001	Modern Indian Language (Odia)	**2-0-0**	**2**

Refer to Department of Odia, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)	AE14003	Modern Indian Language (Hindi)	**2-0-0**	**2**

Refer to Department of Hindi, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)	AE14005	Modern Indian Language (Sanskrit)	**2-0-0**	**2**

Refer to Department of Sanskrit, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)	AE14007	Modern Indian Language (Santali)	**2-0-0**	**2**

Refer to Department of Santali, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)	AE14009	Alternative English	**2-0-0**	**2**

Refer to Department of English, School of Comparative Tribal Languages and Literatures, KISS-DU

Course Code	Course Title	Total Credit	L-T-P
VA16201	**Environment Education and Disaster Management**	**4**	**3-0-1**

Course Objectives: The objective is to make students aware about the environmental functions and issues.

Course Learning Outcomes:

CO1: Students will develop a comprehensive understanding of the complex interactions between humans and the environment, tracing historical developments, analyzing contemporary challenges, and exploring sustainable solutions.

CO2: Students will be able to critically analyze the impact of human activities on natural resources, biodiversity, ecosystems, and the climate, evaluating the effectiveness of conservation efforts and mitigation strategies.

CO3: Students will gain an interdisciplinary perspective by integrating knowledge from fields such as ecology, geography, sociology, economics, and policy studies to address environmental issues holistically.

CO4:Students will cultivate problem-solving skills by applying scientific principles, analytical tools, and ethical considerations to devise innovative solutions for environmental challenges at local, regional, and global scales.

CO5: Students will develop the capacity for active engagement and advocacy in environmental stewardship, recognizing their role as responsible global citizens and agents of positive change in promoting sustainability and resilience.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4

CO1	3	3	2	1	3	1	1	2	1	1	1	2	3	2	1	1
CO2	3	3	3	2	3	1	1	2	2	1	2	2	3	3	2	2
CO3	3	2	2	2	2	2	1	2	2	1	1	2	3	2	2	2
CO4	3	3	3	3	2	1	1	2	2	2	3	2	3	3	3	2
CO5	3	2	2	1	2	2	3	3	2	3	1	3	2	2	1	

Course Inputs:

Unit I: Humans and the Environment

The man-environment interactions: Human as hunger-gatherers; Origin of agriculture; Great ancient civilizations and the environment; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Concept of sustainable development, Sustainable Development Goals (SDGs).

Unit II: Natural Resources and Sustainable Development

Overview of natural resources, renewable and non-renewable resources. Biotic resources: Major type of biotic resources-forests, grassland, wetlands, wildlife. Water resources: Types of water resources-fresh water and marine; Availability and use of water resources; Environmental impact of over-exploitation, issues and challenges; Conflicts over water. Soil and mineral resources: Energy resources: Renewable and non-renewable sources of energy; Non-conventional energy sources-solar, wind, tidal, hydro, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment.

Unit III: Conservation of Biodiversity and Ecosystems

Biodiversity as a natural resource; Biodiversity in India and the world; Biodiversity hotspots; Endangered species, Red data book. Threats to biodiversity and ecosystems: Commercial exploitation of species; Invasive species. Major conservation policies: in-situ conservation approaches; Major protected areas; National and International initiatives for biodiversity conservation; the role of traditional knowledge, community-based conservation. Land use and Land cover change: deforestation, desertification, urbanization, Loss of Biodiversity and it's impact.

Unit IV: Environmental Pollution

Environmental issues at local, regional, and global levels. Air, noise, water, soil, thermal and radioactive pollution. Point sources and non-point sources of pollution.

Air pollution: Sources of air pollution; Primary and secondary pollutants; particulate matter and sulphur dioxide; Volatile Organic compounds (VOCs), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); acid rain; smog, Ozone hole. National Ambient Air Quality Standards.

Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality, Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life.

Soil pollution: Soil pollutants and their sources; Solid waste and their recycling. Noise pollution: Definition of noise; Unit of measurement of noise pollution; Mineral exploitation; Environmental problems due to extraction of minerals and use; Degradation of soil quality and impact on agriculture productivity.

Noise pollution; Noise standards; adverse impact of noise on human health.

Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.

Unit V : Climate Change: Impacts, Adaptation and Mitigation

Understanding climate change, Projections of global climate change with reference to temperature, rainfall, climate variability and extreme events; Climate change projections for the Indian sub-continent.

Impacts of climate change on ocean and land systems; Sea level rise, changes in marine and costal ecosystems; Impacts on forests and natural ecosystem; Impacts on animal species, agriculture, health, urban infrastructure; Climate-resilient development; Indigenous knowledge for adaption to climate change.

Mitigation of climate change: Green House Gas (GHG) Reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; Energy efficiency measures; Renewable energy sources; Carbon capture and storage.

Unit VI :Environmental Management

Introduction to environmental laws and regulations: Constitutional provisions- Article 48A, Article 51A (g) and other environmental rights, Environmental legislations on the forest, wildlife and pollution control. Environmental audit and impact assessment; Waste Management- Concept of 3R (Reduce, Recycle and Recycle) and sustainability.

Unit VII :Environmental Treaties and Legislation

Major International Environmental Agreements: UN Conference on Human Environment 1972, Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing ; Convention on International Trade in Endangered Species of Wild Flora and Fauna(CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India’s status as a party to major conventions

Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air(Prevention and Control of Pollution) Act, 1981 The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules, National Green Tribunal.

Major International organizations and initiatives: United Nations Environment Programme(UNEP), International Union for Conservation of Nature (IUCN), World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere(MAB) programme.

Unit VIII: Disaster Management

Concept of Hazards, Disasters, Natural and man made hazards, Types of hazards, Concept of disaster management, Vulnerability and risk. Nature and characteristics of hazards: Flood, Cyclone, Drought, and Earthquake. Man made hazards – Industrial and Fire.

Disaster management cycle, Pre disaster management, during disaster management, Post Disaster review and management, Preventing, mitigation, preparedness, Adaptation. Disaster Management Plan at National Level, State Level, District Level and Community Level.

Practical:

1. Environment and its analysis

2 Water quality parameters

3 Determination of pH of water samples

4 Determination of acidity of water

5 Determination of Alkalinity of water sample

6 Measurement of turbidity of water samples

7 Determination of conductivity of water sample

8 Estimation of dissolved Oxygen (DO) in water sample

9 Estimation of Biological Oxygen Demand (BOD) of water

10 Estimation of Chemical Oxygen Demand (COD) of water

11 Determination of chloride in water

12 Determination of calcium hardness of water

13 Determination of total hardness of water

14 Determination of minerals in water

15 Visit to Industrial Sewage Disposal Unit

Recommended Learning Resources:

Textbooks

1. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.

2. Das, M.C. Text Book of Ecology, Tata Mc Graw Hills, New Delhi

3. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/standards/

4. Chiras, D. D and Reganolds, J.P. (2010) . Natural Resource Conservation : Management for a Sustainable Future. 10th edition, Upper Saddle River, N.J. Benjamin/Cummins/Person.

5. Fisher, Michael H. (2018) An Environmental History of India-Form Earliest Times to the Twenty-First Century, Cambridge University Press.

6. Harris, France (2012) Global Environmental Issues, 2nd Edition. Wiley-Blackwell.

7. John W. Twidell and Anthony D. (2015). Renewable Energy Sources, 3rd Edition, Weir Publisher (ELBS)

8. Kanchi Kohli and Manju Menon (2021) Development of Environment Laws in India, Cambridge University Press.

Reference Material & Digital Resources

1. Krishnamurthy, K.V.(2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK

2. Ministry of Environment, Forest and Climate Change (2019) A Handbook on International Environment Conventions & Programmes.

3. https://moef.govt.in/wp-content/uploads/2020/02/convention-V-16-CURVE-web.pdf

4. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.

5. Annual Reports of Ministry of Env., Forests and Climate Change, Govt of India, New Delhi

Note: Latest edition of the text books should be used.

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Builds environmental awareness, interdisciplinary knowledge, and sustainability skills
SDG 6	Clean Water and Sanitation	Addresses water resources, pollution, and conservation
SDG 7	Affordable and Clean Energy	Promotes renewable energy and energy efficiency
SDG 11	Sustainable Cities and Communities	Focus on urbanization, disaster management, and environmental planning

SDG 12	Responsible Consumption and Production	Encourages sustainable resource use and waste management (3R principles)
SDG 13	Climate Action	Covers climate change impacts, mitigation, and adaptation strategies
SDG 14	Life Below Water	Addresses marine ecosystems and water pollution
SDG 15	Life on Land	Focus on biodiversity conservation, forests, and land degradation
SDG 16	Peace, Justice and Strong Institutions	Covers environmental laws, policies, and governance frameworks

SEMESTER 2

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10002	Introduction to Fundamental of Power Electronics	2	1	0	3

Prerequisite: Students should have prior knowledge of basic electrical and electronic engineering concepts including AC/DC circuits, semiconductor devices, Ohm's law, Kirchhoff's laws, and basic circuit analysis. Understanding of transformers and electrical measurements is desirable.

Course Objective:

To introduce the fundamentals of power electronics, its devices, and converters for modern applications. To enable understanding of practical applications in renewable energy, EVs, and industrial automation.

Course Outcomes (COs)

CO1: Define power electronics.

CO2:Explain the principles, importance, and applications of power electronics.

CO3: Identify and describe different power semiconductor devices and their characteristics.

CO4: Analyze rectifier and converter circuits for efficiency, ripple, and power factor.

CO5: Design and evaluate DC-AC inverter circuits using PWM techniques for practical applications.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	3	1	1	-	-	-	-	-	-	2	-	2	1	-	-	-
CO2	2	3	2	2	2	-	-	-	-	-	2	2	3	2	2	2	-
CO3	-	3	2	2	1	-	-	-	-	-	2	-	2	3	-	2	-
CO4	3	3	2	3	3	-	-	-	-	-	2	-	2	3	2	2	-
CO5	1	3	2	3	3	-	-	-	-	-	2	-	2	3	2	3	3
Avg	1.6	3	1.8	2.2	1.8	-	-	-	-	-	2	0.4	2.2	2.4	1.2	1.8	0.6

Course Contents

Unit 1: Introduction to Power Electronics (11 Hours)

Definition and Importance of Power Electronics, Applications in Renewable Energy, EVs, and Industrial Automation, Difference Between Power Electronics and Linear Electronics and Overview of Power Semiconductor Devices.

Unit 2: Power Semiconductor Devices (9 Hours)

Types of Power Semiconductor Devices Diodes, Thyristors (SCR), TRIAC, DIAC MOSFET, IGBT, and Power BJT Switching Characteristics and Applications, Gate Drive and Protection Circuits

Unit 3: Converters (Rectifiers) (10 Hours)

Introduction to Rectifiers, Single-phase and Three-phase Rectifiers of Uncontrolled Rectifiers, Performance Parameters: Ripple Factor, Efficiency, and Power Factor, Basic Principle of DC-DC Converters & Applications in Battery Charging and Solar Systems

Unit 4: DC-AC Converters (Inverters) (10 Hours)

Introduction to Inverters, Single-phase and Three-phase Inverters and Applications in UPS and Renewable Energy Systems.

Text Book: -

Power Electronics: Circuits, Devices, and Applications – Muhammad H. Rashid – Pearson Education

Reference Books: -

1. Power Electronics: Converters, Applications and Design – Ned Mohan, Tore M. Undeland, William P. Robbins – Wiley India
2. Fundamentals of Power Electronics – Robert W. Erickson, Dragan Maksimovic – Springer
3. Power Semiconductor Devices – B. Jayant Baliga – Springer
4. Modern Power Electronics and AC Drives – Bimal K. Bose – Pearson Education
5. Power Electronics: Principles and Applications – Joseph Vithayathil – Tata McGraw Hill
6. Power Electronics: Essentials and Applications – L. Umanand – Wiley India
7. Power Electronics: Devices, Circuits, and Industrial Applications – V.R. Moorthi – Oxford University Press

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Efficient energy conversion technologies
8	Decent Work and Economic Growth	Skill development in power electronics
9	Industry, Innovation and Infrastructure	Modern converter and inverter technologies
11	Sustainable Cities and Communities	Applications in renewable and EV systems
13	Climate Action	Supporting energy-efficient systems

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10004	Biomass Power Generation Systems	2	1	0	3

Prerequisite: Students should have an elementary understanding of renewable energy resources, agricultural systems, and organic waste materials. Basic awareness of combustion, heat generation, and environmental sustainability concepts will be helpful for understanding biomass energy technologies.

Course Objective:

To introduce the fundamentals, importance, and global potential of biomass energy.

To provide knowledge of biomass conversion technologies, power plant components, and operation & maintenance for sustainable energy generation.

Course Outcomes:

CO1: Define the Biomass Energy

CO2: Explain the importance of biomass energy, its types, and potential in India and globally.

CO3: Demonstrate the working principles of thermo-chemical, biochemical, and mechanical biomass conversion technologies.

CO4: Illustrate the components and functioning of biomass power plants including boilers, gasifiers, turbines, and CHP systems.

CO5: Analyze operational, maintenance, and environmental aspects of biomass power plants to optimize performance and ensure sustainability.

CO-PO-PSO Mapping

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	2	3	2	1	-	-	-	-	-	1	1	-	3	1	-	-	-
CO 2	2	3	2	2	2	-	1	-	-	-	2	2	3	1	3	-	-
CO 3		3	2	2	3	-	-	1	-	1	2	2	3	3	2	-	-
CO 4	3	3	2	2	3	-	-	-	-	-	3	2	2	3	2	2	-

CO 5	1	2	2	2	3	2	-	-	-	-	2	3	2	3	3	2	2
Avg	1.6	2.8	2	1.8	2.2	0.4	0.2	0.2	-	0.4	2	1.8	2.6	2.2	2	0.8	0.4

Course Contents

Unit 1: Introduction to Biomass Energy (9 Hours)

Definition and Importance of Biomass Energy, Types of Biomass (Woody, Agricultural, Animal, Industrial Waste), Comparison with Other Renewable Energy Sources and Biomass Energy Potential in India & Globally.

Unit 2: Biomass Conversion Technologies (10 Hours)

Thermo-chemical Conversion: Combustion, Gasification, Pyrolysis

Biochemical Conversion: Anaerobic Digestion, Fermentation

Mechanical Processing: Briquetting and Pelletization

Unit 3: Biomass Power Plant Components & Working (11 Hours)

Biomass Feedstock Collection & Preparation, Boilers and Steam Turbines in Biomass Plants, Gasifiers and their Functioning and Biomass Generators, Power Distribution and CHP (Combined Heat & Power) Systems

Unit 4: Operation & Maintenance of Biomass Power Plants (10 Hours)

Biomass Storage & Handling, Fuel Feeding Systems & Efficiency Optimization, Emission Control & Environmental Impact, Routine Maintenance & Safety Measures and Troubleshooting Common Issues.

Text Book

Biomass Energy – G.D. Rai, *Khanna Publishers*

Reference Books

Biomass to Renewable Energy Processes – Jay Cheng, *CRC Press*

Biomass: Principles and Applications of Biomass Conversion – Yebo Li & Samir Kumar Khanal, *Wiley*

Biomass Gasification, Pyrolysis and Torrefaction: Practical Design and Theory – Prabir Basu, *Academic Press (Elsevier)*

Renewable Energy: Power for a Sustainable Future – Godfrey Boyle, *Oxford University Press*

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Biomass-based renewable power generation
8	Decent Work and Economic Growth	Rural employment through biomass processing
9	Industry, Innovation and Infrastructure	Biomass conversion technologies
12	Responsible Consumption and Production	Waste-to-energy practices
13	Climate Action	Reduction of fossil fuel dependency

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10006	Roof-top Solar PV Installation	2	0	1	3

Prerequisite: Students should have completed or possess equivalent knowledge of Fundamentals of Solar PV Power System. Learners should understand solar panel components, DC electrical systems, series and parallel connections, basic site survey concepts, and electrical safety precautions related to solar installations.

Course Objective:

To equip students with advanced skills in site assessment, electrical components, installation, and maintenance of solar PV systems for efficient and safe energy generation.

Course Outcomes

CO1: Explain site assessment and load calculation for solar PV systems.
CO2: Apply DC/AC electrical concepts and PV panel connections.
CO3: Select suitable wiring, protection devices, and mounting structures.
CO4: Demonstrate solar PV installation and safety practices.
CO5: Analyze inverter integration, grid connectivity, and hybrid systems.
CO6: Perform testing, troubleshooting, and maintenance of solar PV systems.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	-	3	2	2	3	2	-	-	2	-	2	2	2	2	2	-	-
CO2	3	3	-	2	3	-	-	-	-	-	2	-	2	3	-	2	-
CO3	-	3	-	2	2	-	-	-	-	-	2	-	2	3	2	2	-
CO4	1	3	-	2	3	-	-	-	-	-	2	3	2	3	3	2	-
CO5	-	3	-	2	3	-	-	2	-	-	2	2	3	3	2	3	2
CO6	2	3	-	2	3	3	-	2	-	-	2	2	2	3	3	3	2
Avg.	1	3	0.33	2	2.83	0.83	-	0.66	0.33	-	2	1.5	2.16	2.83	2	2	0.66

Course Contents

Unit 1: Advanced Site Assessment & Electrical Components (10 Hours)

Detailed site survey techniques (roof strength, shading analysis), Load assessment and energy consumption calculation, Solar panel selection based on efficiency & technology, DC and AC electrical fundamentals for solar PV systems and Series and parallel connections for voltage & current optimization

Unit 2: Wiring Techniques, Mounting Structures & Installation Procedures (12 Hours)

Selection of cables, connectors, fuses, and circuit breakers, Earthing, surge protection, and lightning protection for safety, Types of mounting structures (fixed, adjustable, tracking), Installation techniques for different roof types (RCC, metal, tile), Panel tilt angles and orientation optimization and Fastening methods and wind load considerations

Unit 3: Inverter Integration & Grid Connectivity (9 Hours)

Types of inverters (string, central, micro) and their working, Inverter installation, programming, and troubleshooting, Net metering and grid interconnection process and Hybrid solar systems with battery backup

Unit 4: Testing, Commissioning & Maintenance (9 Hours)

Performance testing using multimeters and solar analyzers, Checking voltage, current, and power output of the system, Common faults and troubleshooting techniques and Cleaning, maintenance schedules, and system longevity

Text Book

Solar Photovoltaic Installations: Testing, Commissioning and Maintenance – *Saibaba Reddy*

Reference Books

1. Solar Photovoltaic Technology Production: Basics, Technologies, and Applications – *Chetan Singh Solanki*
2. Photovoltaic Systems – *James P. Dunlop*
3. Grid-Connected Solar Electric Systems – *Geoff Stapleton & Susan Neill*
4. Renewable Energy Engineering and Technology: Principles and Practice – *S. Rao & B.B. Parulekar*
5. Handbook of Solar Photovoltaic Systems – *P. Jayarama Reddy*

PRACTICAL

1. Designing a Rooftop Solar PV System
2. Structural Load Testing for Rooftop Installations
3. Installation of DC Combiner Box & Protection Devices
4. AC Wiring & Distribution Board Connection
5. Testing and Commissioning of On-grid PV System
6. Integration of a Hybrid Solar System with Battery Backup
7. Net Metering Installation & Grid Synchronization
8. Troubleshooting Inverter & Panel Performance Issues

Link: https://renewablelab.niu.edu/experiments/solarPanel

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Rooftop solar PV deployment
8	Decent Work and Economic Growth	Solar installation skill development
9	Industry, Innovation and Infrastructure	Solar infrastructure and grid integration
11	Sustainable Cities and Communities	Clean urban energy systems
13	Climate Action	Carbon emission reduction through solar energy

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Courses	BR10008	Electrical Systems	2	0	1	3

Prerequisite: Students should possess basic understanding of electrical engineering concepts such as current, voltage, resistance, AC/DC systems, electrical safety, and simple wiring practices. Familiarity with transformers, electrical symbols, and measuring instruments will be advantageous.

Course Objective:

To provide fundamental knowledge of electrical supply systems, switching devices, earthing methods, magnetic circuits, transformers, and DC machines. The course also develops analytical skills for three-phase load and machine performance calculations.

Course Outcomes

CO1: Explain single-phase and three-phase electrical supply systems and switching devices.
CO2: Identify electrical protection devices and phase sequence in power systems.
CO3: Differentiate earthing and grounding methods with safety standards.
CO4: Analyze magnetic circuit parameters and transformer characteristics.
CO5: Apply transformer equations and equivalent circuit concepts in electrical systems.
CO6: Calculate three-phase load parameters, power, and power factor in star and delta connections.

CO-PO-PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	2	3	2	2	-	-	-	-	1	-	2	-	2	2	-	-	-
CO 2	-	3	-	2	3	-	-	-	-	-	2	2	2	3	2	-	-
CO 3	3	2	-	2	-	-	1	-	-	3	2	3	1	2	3	-	1
CO 4	2	3	-	2	2	2	-	-	-	-	2	-	2	3	-	2	2
CO 5	-	3	-	2	3	-	-	-	1	-	3	-	2	3	-	2	-
CO	1	3	-	2	3	-	-	-	-	-	3	-	2	3	2	2	-

6																	
Avg.	1.33	2.83	0.33	2	1.83	0.33	0.18	-	0.33	0.5	2.33	0.83	1.83	2.67	1.17	1	0.5

Course Contents

Unit 1 – Fundamentals of Electrical Supply & Switching Devices (10 Hours)

Structure of single-Phase vs. three-phase systems, Standard phase sequence (R-Y-B), Basic switching/protection hardware: one-way & two-way switches, fuses, miniature circuit-breakers (MCBs)

Unit 2 – Earthing, Grounding & Electrical Safety (10 Hours)

Purpose of the neutral conductor in 3-φ networks, Earthing vs. grounding: concepts, differences, standards, Earthing methods – plate, pipe, rod – with installation drawings and Fault-current path, touch/step potential, routine maintenance of earthing systems

Unit 3 – Magnetic Circuits & Transformers (8 Hours)

Magnetic circuit parameters: flux, m.m.f., permeability, reluctance, B–H curve: plotting & interpretation (saturation, knee-point, hysteresis loop), Comparison of magnetic and electric circuits, e.m.f. analogy and Single-phase transformer: construction, working principle, equivalent circuit, emf equation.

Unit 4 – Three-Phase and Load Calculations (12 Hours)

Identification of line & phase voltage in star/delta networks, Three-phase balanced loads: Δ and Y connections, phase & line values, power & power-factor computation for resistive–inductive coils

Text Book

V. K. Mehta, Rohit Mehta – Principles of Electrical Engineering (S. Chand)

Reference Books

Chakrabarti, S. Nath, C. K. Chanda, S. Banerjee – Basic Electrical Engineering (McGraw Hill)

D. P. Kothari, I. J. Nagrath – Basic Electrical Engineering (Tata McGraw Hill)

E. B. L. Theraja, A. K. Theraja – Electrical Technology Vol. I & II (S. Chand)

J. B. Gupta – Fundamentals of Electrical Engineering and Electronics (S. K. Kataria & Sons)

H. Cotton – Advanced Electrical Technology (Reem Publications)

M. L. Anand – Basic Electrical Engineering (Phi Learning Pvt. Ltd.)

Edward Hughes – Electrical and Electronic Technology (Pearson Education)

Virtual Lab: (Practical)

Welcome to Virtual Labs

Welcome to Virtual Labs

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Efficient electrical supply systems
8	Decent Work and Economic Growth	Technical competency development
9	Industry, Innovation and Infrastructure	Electrical infrastructure and transformer systems
11	Sustainable Cities and Communities	Reliable electrical distribution
12	Responsible Consumption and Production	Energy-efficient electrical practices

Course Code	Course Title	Total Credit	L-T-P
CS13002	**Data Analytics**	**3**	**2-0-1**

Course Objectives: The objective of this course is to provide an understanding of computers, computer operating system, and application of relevant software in managerial decision making.

Course Learning Outcomes

CO1: Students will be able to analyze complex data sets, identify patterns, and propose data-driven solutions.

CO2:Students will critically evaluate data analysis methods, considering their limitations and applicability.

CO3:Students will demonstrate proficiency in using statistical and computational tools for data analysis.

CO4:Students will be able to collect, preprocess, and validate data from various sources.

CO5:Students will effectively communicate data analysis results through visualizations, reports, and presentations.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	1	1	1	2	3	2	2	3	2	1	1
CO2	2	2	3	2	2	1	1	1	2	1	1	2	2	2	1	1
CO3	3	3	3	3	2	1	1	1	2	2	3	2	3	3	2	2
CO4	3	3	2	3	2	1	1	1	2	1	2	2	2	2	3	1
CO5	2	2	2	2	3	3	1	2	2	1	2	2	2	2	1	1

Course Input:

1. Introduction to Data Analytics

· Overview of data analytics, its importance, and applications, Data types (structured, unstructured) and data sources, Data preprocessing: cleaning, transformation, and normalization, Introduction to Python/R for data analysis

2. Descriptive Analytics

Summary statistics: mean, median, variance, etc., Data visualization: histograms, scatter plots, box plots, Exploratory data analysis (EDA), Case study: analyzing a real-world dataset

3. Predictive Analytics

Regression analysis: linear regression, multiple regression, Classification: logistic regression, decision trees, k-nearest neighbors. Model evaluation and validation, Hands-on exercises using scikit-learn or similar libraries

4. Prescriptive Analytics

Optimization techniques: linear programming, integer programming, Decision support systems, Case study: optimization in supply chain management

5. Advanced Topics in Data Analytics

Time series analysis, Clustering techniques: k-means, hierarchical clustering, Text mining and sentiment analysis, Ethical considerations in data analytics

Textbook:

1. "Data Science for Business" by Foster Provost and Tom Fawcett

Reference Books:

1. "Python for Data Analysis" by Wes McKinney
2. "Introduction to Statistical Learning" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani

Recommended Learning Resources:

Textbooks

1. "Data Science for Business" by Foster Provost and Tom Fawcett

Reference Material & Digital Resources

1. "Python for Data Analysis" by Wes McKinney
2. "Introduction to Statistical Learning" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani

Note: Latest edition of the text books should be used.

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Development of analytical, computational, and problem-solving skills
SDG 8	Decent Work and Economic Growth	Enhances employability through data analytics and digital skills
SDG 9	Industry, Innovation and Infrastructure	Supports innovation through data-driven solutions and technologies
SDG 12	Responsible Consumption and Production	Data-driven optimization of resources and efficient decision-making
SDG 16	Peace, Justice and Strong Institutions	Ethical use of data, transparency, and accountability in decision-making

Ability Enhancement Course (Choose any One)		AE14002	Translation Studies (Odia)	**2-0-0**	**2**

Refer to Department of Odia, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)		AE1400 4	Translation Studies (Hindi)	**2-0-0**	**2**

Refer to Department of Hindi, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)		AE1400 6	Translation Studies (Sanskrit)	**2-0-0**	**2**

Refer to Department of Sanskrit, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)		AE1400 8	Translation Studies (Santali)	**2-0-0**	**2**

Refer to Department of Santali, School of Comparative Tribal Languages and Literatures, KISS-DU

Ability Enhancement Course (Choose any One)		AE1401 0	Translation Studies (English)	**2-0-0**	**2**

Refer to Department of English, School of Comparative Tribal Languages and Literatures, KISS-DU

Course Code	Course Title	Total Credit	Credit Hours
VA16124	Enhancement of Active Citizenship and Democratic Values	2	2-0-0

Course Objectives:

This course aims to enable the students to learn about democracy, human rights, participatory governance and active citizenship as well as develop the knowledge and skills for environmental sustainability.

Course Learning Outcomes:

CO1: Define and explain key concepts such as citizenship, democracy, human rights, active citizenship, and environmental sustainability in the context of Indian society and global citizenship.

CO2: Apply the principles of active citizenship and democratic values by engaging in community-based projects, volunteering activities, or service learning experiences that promote environmental sustainability and social inclusion.

CO3: Analyse the differential rights of various social groups in India, considering factors like caste, gender, and tribe.

CO4: Design and propose solutions for enhancing active citizenship and democratic values in society, such as creating awareness campaigns, public policy advocacy (e.g., RTI, Forest Rights Act), or proposing measures to combat environmental issues like plastic waste.

CO5: Critique existing policies and initiatives, such as the PESA Act or the Right to Information Act, and evaluate their effectiveness in promoting active citizenship and democratic engagement in India, with a focus on social justice and environmental responsibility.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PS	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4

Os																
CO1	3	2	1	2	3	2	1	2	2	1	2	2	3	2	1	1
CO2	3	3	3	2	3	2	3	3	2	3	2	2	3	2	2	3
CO3	3	3	3	3	3	2	1	2	2	2	1	2	3	3	3	2
CO4	3	3	3	3	3	3	2	3	2	3	3	3	2	2	2	3
CO5	3	3	3	3	3	3	2	3	2	3	3	3	2	3	3	3

Course Input:

Unit – I Citizenship in a Democratic Society (14 lectures)

Meaning and significance of citizenship in a democracy, differentiated citizenship Rights for various social groups, Qualities of a good citizen- Volunteering, mutuality and democratic engagement, Promoting Environmental Sustainability and understanding the meaning of responsible citizenship, Understanding the concept of service learning, Role of teacher in promoting active citizenship in students. Civil society and its features, Global and digital citizenship

Unit – II Dimensions of Active citizenship In India (16 lectures)

Citizenship and Indian constitution- Fundamental right, Understanding multiculturalism in Indian society, Differential rights of different social groups in India- caste, tribe and gender, Civic engagement through public policy: PESA Act, 1996, Forest Rights Act 2006, Right to in formation Act, Themes for Group Discussion, Environmental sustainability, Government ban on use of polythene and plastic, Teacher's role in developing secular society, Role of Active Citizen in enhancing the quality of democracy through RTI , Role of Active Citizen in eradication of gender bias in society, Active Citizenship and Social Inclusion, Responsibilities of active citizen in digital world

Recommended Learning Resources:

Textbooks

1. Anupama Roy, *Mapping Citizenship in India,* Oxford University Press, Delhi, 2010.
2. Claiming the State: Active Citizenship and Social Welfare in Rural India, Gabrielle Kriks-Wisner
3. Derek Heater, what is Citizenship? Cambridge: Policy, 1999
4. Keith Faulks, *Citizenship,* London and New York: Routledge, 2000.
5. Reflections: Active Citizenship: The Role of Higher Education. National Union of Students.

Reference Material & Digital Resources

1. Active Citizens Facilitator's toolkit, British Council
2. Active Citizenship: A Teacher Toolkit, Francine Britton
3. Barber, B. (2003). *Strong democracy: Participatory politics for a new age*. California: University of California.

SDG Mapping

SDG No.	SDG Title	Nature of Contribution

SDG 4	Quality Education	Promotes civic awareness, democratic values, and social responsibility
SDG 5	Gender Equality	Focus on gender justice and equality in citizenship
SDG 10	Reduced Inequalities	Addresses rights of marginalized groups (caste, tribe, gender)
SDG 13	Climate Action	Promotes environmental sustainability and awareness
SDG 16	Peace, Justice and Strong Institutions	Strengthens democratic participation, governance, and transparency

Course Code	Course Title	Total Credit	Credit Hours
VA16134	**Inclusive Education and Gender Equality**	**2**	**2-0-0**

Course Objectives: The course aims to provide students with a comprehensive understanding of the concepts of social exclusion and inclusion, focusing on the need for inclusive education in both global and Indian contexts. Students will explore the role of gender in education and society, analyzing how gender inequality affects access to educational opportunities, particularly for girls. The course will equip students with the knowledge of key policies, such as the Right to Education Act (2009) and the National Policy on Education (2020), and practical strategies for creating inclusive educational environments. By the end of the course, students will be empowered to promote gender equality and implement inclusive practices within their own educational contexts.

Course Learning Outcomes:

CO1:Define and explain the concepts of social exclusion and inclusion, and the principles of inclusive education, within the context of India and global practices.

CO2:Apply the knowledge gained to identify socially excluded groups and propose strategies for promoting inclusive education within various educational settings.

CO3:Analyze the impact of gender inequalities on education, specifically for girls, and examine the cultural, political, and economic barriers to implementing gender equality in education.

CO4:Design and develop strategies for creating inclusive classroom environments, using differentiated instructions, peer-mediated learning, and collaborative strategies to enhance student participation and learning outcomes.

CO5:Critically evaluate the effectiveness of national policies such as NCF (2005), RTE Act (2009), and NEP-2020 in promoting inclusive education and gender equality, and suggest improvements based on research findings and case studies.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	1	2	3	2	1	3	2	1	1	2	3	2	1	1
CO2	3	3	3	3	3	2	2	3	2	2	2	2	3	2	3	3
CO3	3	3	3	2	3	2	1	3	2	2	1	2	2	3	3	2
CO4	3	3	3	3	3	2	3	3	2	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	2	3	3	3	2	3	2	3	3	3

Course Input:

UNIT- I Understanding Inclusion and Inclusive Education

Concept of Social Exclusion and Inclusion, Identifying socially excluded categories in India, Manifestation of Social exclusion in the process of imparting quality education , Concept and Importance of Inclusive Education, Objectives, Scope and Key and Guiding Principles of Inclusive Education ,Equity, Safety, Leadership, Empowerment

Policy perspectives: Initiatives to promote Inclusive Education: NCF (2005), RTE Act (2009), PWD Act (2016), Sarva Shiksha Abhiyan, Rashtriya Madhyamik Shiksha Abhiyan,NEP-2020 (Plans and Programs regarding Inclusive education)

Planning and management of inclusive classrooms- Differentiated Instructions: Peer Mediated Instructions: Class Wide Peer Tutoring, Peer Assisted Learning Strategies, Collaborative and Co-operative Learning Strategies

UNIT – II Gender Equality in Education

Basic Concepts: Sex, Gender, Sexuality. Masculinity and other Sexualities, Gender Stereotypes, Patriarchy as an ideology and practice. Cultural, Political and Economic barriers for implementing gender equality in Education. Major issues and challenges for development of Girl Child: Early marriage, Dowry, Gender Violence, Sexual Harassment. Strategies for Women Empowerment in India

Practical Work:

A Case study of educational needs of a differently able student

Visit to NGO promoting Gender Equality and prepare a report (Study on KISS)

Prepare presentation on recent developments in the field of Gender Equality

Write a Research report on issues and trends in Gender equality

Prepare e-Poster or e-mind map on any one topic

Recommended Learning Resources:

Textbooks

1. "Inclusive Education: A Practical Guide to Supporting Diversity in the Classroom" by Sally Tomlinson
2. "The Routledge Companion to Special Education" edited by Lani Florian
3. "Inclusive Education: A Global Agenda" by Mel Ainscow
4. "Differentiated Instruction: A Guide for Inclusive Teaching" by Amy Benjamin
5. "Special Education in Contemporary Society: An Introduction to Exceptionality" by Richard M. Gargiulo and Jennifer L. Kilgo
6. Gender and Education: An Encyclopedia" edited by Barbara J. Bank
7. The Right to Education: Law, Policy, and Practice" by S. K. Sharma
8. The Right to Education Act in India: A Critical Perspective" by Rohit Kumar
9. National Policy on Education 2020: A Critical Review" by Usha Ramanathan

Reference Material & Digital Resources

1. Anu R., Vu, P. (2018) Gender Inequality in Education and Kinship Norms in India, Feminist Economics, 24:1, 142-167, DOI:10.1080/13545701.2017.1364399
2. Batliwala, S. 2013, Engaging with Empowerment: An intellectual and Experimental Journey, New Delhi: Women Unlimited.
3. Kambhampati, Uma S. 2009. "Child Schooling and Work Decisions in India: The Role of Household and Regional Gender Equity." Feminist Economics 15(4): 77–112. doi: 10.1080/13545700903153997
4. Nakray, K. (2018). Gender and education policy in India: Twists, turns and trims of transnational policy transfers. *International Sociology*, *33*(1), 27– 44.https://doi.org/10.1177/0268580917745769

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Promotes inclusive and equitable quality education
SDG 5	Gender Equality	Focuses on gender justice and empowerment
SDG 10	Reduced Inequalities	Addresses social exclusion and marginalized groups
SDG 16	Peace, Justice and Strong Institutions	Promotes equality, fairness, and policy awareness
SDG 17	Partnerships for the Goals	Encourages collaboration for inclusive development

Course Code	Course Title	Total Credit	Credit Hours
VA16142	**Combating Radicalism through Education**	**2**	**2-0-0**

Course Objectives: The course aims to provide students with an in-depth understanding of key concepts such as human rights, social harmony, and sustainable development, with a particular focus on preventing radicalization and promoting peace. Students will explore the causes and impacts of radicalism and violent extremism on society, alongside learning about the critical role education plays in countering radicalization. This course will equip students with the knowledge of various legal frameworks and strategies for countering radicalization, empowering them to contribute to creating peaceful, inclusive societies. Additionally, students will develop the skills to motivate others, particularly their peers, to embrace values of peace, social harmony, and sustainable development.

Course Learning Outcomes :

CO1-Define and **explain** the fundamental concepts of human rights, social harmony, and sustainable development.

CO2- Apply the knowledge of human rights and peace education to **design** projects or initiatives aimed at reducing radicalism.

CO3- Analyze the impact of radicalization on societal peace and security.

CO4-Create educational tools, such as case studies, projects, or presentations, that focus on peace education.

CO5- critically evaluate the effectiveness of different peace education strategies, human rights frameworks, and legal measures in countering radicalization.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	1	2	3	2	1	3	2	1	1	2	3	2	1	1
CO2	3	3	3	3	3	2	2	3	2	3	2	2	3	3	3	3
CO3	3	3	3	2	3	2	1	3	2	2	1	2	2	3	3	2
CO4	3	2	3	3	3	3	2	3	2	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	2	3	3	3	2	3	2	3	3	3

Course Input:

Unit-I-Understanding the basic concepts related to Human Rights (15 lectures)

State, Equality, liberty, justice and Human Rights, Universal Declaration of Human Rights, Common Good, Harmony for a better world, Ubuntu: Humanity (I am because you are/humanity towards others)

Unit-II Interrogating Radicalism Through Development and Peace Education (15 lectures)

Understanding concept of radicalism and its implications for peaceful coexistence in a society

Defining development – From empowerment to entitlement perspectives, Features of developing countries, Human Development Index, Gender Development Index, Gender Empowerment Index, Empowering to skill development, entrepreneurship development and capability enhancement. Need for Peace Education to counter Radicalism, Best practices, case studies showing end of radicalism through peace education

Practical

1. To document case studies, demonstrating end of radicalism through peace and harmony

2. To make a project on “Harmony for the Better World” for peace and happy world

Recommended Learning Resources:

Textbooks

1. "Human Rights: A Very Short Introduction" by Andrew Clapham
2. "Peace Education: A Global Perspective" by Monisha Bajaj
3. "Understanding Radicalization: Theories, Causes, and Responses" by Magnus Ranstorp
4. "The Politics of Human Rights" by David Held and Henrietta L. L. Lanting
5. "Sustainable Development Goals: A Critical Introduction" by David A. McDonald
6. "Radicalization and Counter-Radicalization: The Ethics of Preventing Terrorism" by John Horgan
7. "The Universal Declaration of Human Rights: Origins, Drafting, and Intent" by Johannes Morsink
8. "Peace and Conflict Studies" by David P. Barash

Reference Material & Digital Resources

1. Estlund, David, 2016, The Oxford Handbook of Political Philosophy, Oxford, London.
2. Kymlicka, Will, 2014, Contemporary Political Philosophy, Oxford HED, London.
3. O.P.Gauba, Introduction to Political Theory, MacMillan Publication

4. Sen Amartya, Development As Freedom, Alfred Knopf, 2000
5. Swift, Adam, 2001, Contemporary Political Philosophy, Polity Press, London.
6. Wolff, Jonathan, 2016, An Introduction to Political Philosophy, Oxford University Press, London.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Promotes peace education and awareness of human rights
SDG 5	Gender Equality	Encourages gender empowerment and inclusion
SDG 10	Reduced Inequalities	Addresses social exclusion and promotes inclusion
SDG 16	Peace, Justice and Strong Institutions	Focuses on peacebuilding, justice, and countering radicalism
SDG 17	Partnerships for the Goals	Encourages collaboration for peaceful and inclusive societies

Course Code	Course Title	Total Credit	Credit Hours
VA16146	**Indian Knowledge System**	**2**	**2-0-0**

Course Objectives: The course on Indian Knowledge System for Commerce Students aims to introduce students to the profound and diverse intellectual traditions of India, with a focus on how these ancient knowledge systems can be integrated into modern commerce, business, and economics. This course will explore Indian philosophical, ethical, and scientific contributions, emphasizing the holistic approach to business practices, sustainability, and corporate social responsibility. Students will learn about the historical, cultural, and intellectual foundations that shaped Indian commerce and business models, and how principles like Dharma (ethics), Karma (action), and the interconnectedness of society can influence modern-day business strategies.

Course Learning Outcomes:

CO1- Define and explain key concepts such as Dharma, Karma, Ahimsa, and sustainability, and understand their relevance to modern commerce and business practices.

CO2- Apply the principles of Indian Knowledge to case studies of contemporary businesses and corporate governance practices, identifying ethical issues and proposing solutions based on Indian ethical traditions.

CO3- Analyse the role of Indian economic and philosophical traditions in shaping business practices in ancient and modern India, identifying key differences and continuities.

CO4- design business models or strategies that integrate Indian ethical principles (such as Dharma and Karma) into the operations of a modern corporation, promoting ethical conduct and sustainability.

CO5- Critically evaluate the effectiveness of integrating Indian Knowledge Systems into contemporary business practices, discussing potential challenges and benefits, and proposing recommendations for improvement.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	1	2	3	2	1	3	2	1	1	2	3	2	1	1
CO2	3	3	3	3	3	2	2	3	2	2	2	2	3	3	3	3
CO3	3	3	3	3	3	2	1	3	3	2	1	2	2	3	3	2
CO4	3	3	3	3	3	3	2	3	2	3	2	3	3	2	2	3
CO5	3	3	3	3	3	3	2	3	2	3	2	3	2	3	3	3

Course Input:

Unit I: Indian Ethical Foundations for Business (14 lectures)

Introduction to Indian Philosophy and Commerce: Understanding the ancient Indian views on ethics, business, and society as framed by the Vedas, Upanishads, and other classical texts. Dharma and Commerce: Exploring the concept of Dharma (moral and ethical duties) and its application in business ethics, corporate governance, and leadership. Karma and Responsibility in Business: Examining the role of individual actions (Karma) and how it aligns with corporate social responsibility (CSR), sustainable business practices, and social justice. The Role of Trust and Relationships: Discussing the significance of interpersonal relationships in Indian business practices, such as the importance of trust, reputation, and long-term business partnerships.

Unit II: Indian Economic Thought and Sustainable Business Practices (16 lectures)

Ancient Indian Contributions to Commerce: Insights into ancient Indian trade, banking, and economic systems, including the role of guilds, barter systems, and the evolution of economic transactions. The Role of Sustainability in Indian Knowledge: Exploring the principles of ecological sustainability and how ancient Indian practices like Ahimsa (non-violence) and Vastu Shastra (architecture for harmony) relate to modern-day environmental sustainability and green business. Indian Concepts of Wealth and Prosperity: Examining the holistic view of wealth in Indian thought, as discussed in texts such as the Arthashastra and Manusmriti, and its relevance to contemporary wealth creation, resource management, and economic development. Modern Integration of Indian Knowledge in Commerce: Case studies on how contemporary businesses incorporate Indian ethical values, sustainability, and responsibility in their operations, particularly in the context of India's growing economy and globalization.

Recommended Learning Resources:

Textbooks

1. "Indian Business Ethics" by Pradip N. Khandwalla

2. "The Arthashastra" by Kautilya (Chanakya)

3. "The Bhagavad Gita: A Guide to Managing the Business of Life" by R. C. Sharma

4. "Corporate Governance in India: A Historical Perspective" by A. C. Fernando

5. "Vedic Economics: The Art of Sustainable Living" by H. R. Khanna

Reference Material & Digital Resources

1. "Karma and Business: Insights from Indian Philosophy" by S. R. Sharma

2. "The Vedas and the Upanishads: Wisdom for Modern Business" by S. S. Sivananda

3. "Dharma and the Indian Economy" by T. K. S. Pillai

4. "Sustainable Development: Perspectives from Indian Philosophy" by Nandini Mehta

5. "The Wisdom of Indian Management" by Rajiv Misra

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Promotes value-based and holistic education
SDG 8	Decent Work and Economic Growth	Encourages ethical and sustainable business practices
SDG 10	Reduced Inequalities	Promotes fairness and inclusive growth
SDG 12	Responsible Consumption and Production	Supports sustainable business and resource use
SDG 16	Peace, Justice and Strong Institutions	Encourages ethical governance and justice in business

Course Code	Course Title	Total Credit	Credit Hours
VA16394	**Flutter Application Development**	**2**	**1-0-1**

Course Objectives:

This course aims to enable students to develop cross-platform applications for Android, iOS, and web while implementing best programming practices. They will also gain experience in using GitHub for source code management and app deployment to the Play Store and App Store.

Course Learning Outcomes:

CO1: Understand the fundamental concepts, principles, and technologies involved in application development.

CO2: Analyze user interface (UI) and design principles to develop user-friendly and visually effective applications.

CO3: Apply appropriate tools and techniques to design and develop functional applications.

CO4: Integrate backend services, databases, and APIs to ensure effective application functionality and data management.

CO5: Demonstrate the ability to deploy, test, and publish applications on appropriate platforms.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	2	3	2	1	1	2	1	2	2	3	2	1	1
CO2	2	3	2	2	3	2	1	1	2	2	2	2	2	3	1	1
CO3	3	3	3	3	3	2	2	1	2	3	3	2	3	2	2	2
CO4	3	3	3	3	3	2	1	2	3	2	3	2	2	2	3	2
CO5	2	2	2	3	3	3	2	2	3	3	3	3	2	2	2	2

Course Input:

Unit I: Introduction to Mobile App Development, Dart, Flutter & Git (15 Lectures)

Introduction to mobile app development, History, Platforms, Native vs Hybrid Apps, Existing tools, Why Flutter?, Why Dart ?, Mobile Development key terms. Dart: History, Introduction, Environment, Syntax, Data Types, Variables, Operators, Loops,Decision making, List, Map, Functions, Parameters (Default+Named), Class, Constructor, Inheritance, Interfaces, Overriding, Operator overloading, Keywords, Null Safety, Getters & Setters, Exception handling, Lambdas, Higher Order Functions, Closures, Future, Stream. Flutter: Introduction, UI, Architecture, Key Terms, Development Environment. Git: Creating a repository on local & GitHub, Pushing local changes into the repository, Pulling and cloning projects from the repository, Branching, Merging & Pull requests

Unit II: Designing and Publishing Apps (15 Lectures)

Flutter App Structure, Introduction to Widgets, Build method, Stateful vs Stateless Widgets, Some Important Widgets, Layout widgets, Handling gestures, Building complex UI, Navigation &Routing, REST APIs, Working with JSON, Using Assets, File Handling, SQLite & Firebase, Forms & validation, Animations Basics, Reactive Programming: Streams and Data handling, State Management with Flutter, Basic Testing: Unit and Integration Testing, Custom Components, App Publishing, Project Management Basics.

Recommended Learning Resources:

Textbooks

1. Flutter Documentation - https://docs.flutter.dev/
2. Flutter for Beginners: An introductory guide to building cross-platform mobile applications with Flutter 2.5 and Dart, 2nd Edition – Thomas Bailey, Alessandro Biessek

Reference Material & Digital Resources

Free Code Camp -Flutter Course for Beginners – 37-hour Mobile App Development Tutorial (freecodecamp.org)

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Enhances digital and technical skills in application development
SDG 8	Decent Work and Economic Growth	Improves employability in IT and software development sectors
SDG 9	Industry, Innovation and Infrastructure	Promotes innovation through app development and digital solutions
SDG 12	Responsible Consumption and Production	Encourages efficient digital solutions reducing resource usage
SDG 16	Peace, Justice and Strong Institutions	Promotes secure and ethical digital applications

Course Code	Course Title	Total Credit	Credit Hours
VA16486	**Pioneering Service Learning And Community Development**	**2**	**2-0-0**

Course Objectives:

Pioneering, Service Learning, and Community Development are interconnected concepts that involve proactive engagement with communities to address needs, foster positive change, and enhance the well-being of individuals and society. This course emphasizes the experiential learning, encouraging students to apply theoretical knowledge in real-world settings.

Course Learning outcomes:

CO1- Develop a strong sense of civic responsibility and an understanding of the global context of local community issues.

CO2- Exhibit a commitment to ethical behavior and social justice principles in all aspects of community work.

CO3- Apply knowledge, skills, and attitudes in an integrated manner to develop and implement a community project.

CO4-Foster reflective thinking on personal growth and community impact. Encourage critical analysis of the societal and systemic issues related to community development.

CO5- Critically analyzing personal and community development experiences. Develop the decision making skill.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	1	2	3	2	2	3	2	2	1	2	3	2	2	1
CO2	3	3	2	2	3	2	1	3	2	2	1	2	2	2	2	1
CO3	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3	3
CO4	3	3	3	3	3	2	2	3	2	2	2	3	2	2	2	2
CO5	3	3	3	3	3	3	2	3	2	3	2	3	2	2	2	3

Course Contents:

Unit-IPioneering and Service Learning (15 Lectures)

History of Rovers andRanger, Aims , Promise & Law, Principles, Motto, Sign of Rovers and Rangers, History of Rovering and Rangering (scout &guide), Principles of scout guide movement, Pioneering Skills: importance of pioneering and Types of pioneering**,** Basic Pioneering, Advanced Pioneering**,** Knot Tying.

Service learning and Activities: Scouting Principles and Service ,role and responsibilities of volunteers , Women Empowerment Programme, Blood Donation Camp, Legal Awareness Programme, health camp, attend Survive Camp, Swachha Bharat Programme, Environment Protection Programme, celebration of national and international days , BSG Foundation Day / BSG Flag Day, Independence Day, Republic Day, National Unity Day, Thinking Day (Girl Guides), St. George's Day (Scouts & Guides), World Scout Day: Environment Day (June 5th), International Day of Peace, International Day for Disaster Reduction , Youth Leadership and Empowerment:principles and practices of effective youth leadership. Participants will develop skills for self-leadership, team leadership, and community engagement

Unit- II CommunityDevelopment /Community Service Projects:

Community Health and Well-being, Community Development Strategies, Identifying and analyzing the needs of communities, Community Service Projects, Designing and implementing community service projects that address local needs. Leadership Training and Team Building Activities, Engaging in team-building exercises and activities to strengthen group cohesion. Emphasizing the importance of collaboration in community development.

Recommended Learning Resources:

Textbooks

1. The Scout Handbook by Boy Scouts of India

2. Scouting and Guiding Around the World by John Long

3. The History of Girl Guiding by Elizabeth Hammill
4. The History of Scouting by John Thurman
5. The Girl Scout Counselor's Guide by Girl Scouts of the India
6. Scout/Guide Proficiency Badges Book
7. Bharat Scouts and Guides Handbook

Reference Material & Digital Resources

1. Centers for Disease Control and Prevention (CDC): https://www.cdc.gov/
2. World Health Organization (WHO): https://www.who.int/
3. Public Health England (PHE): https://www.gov.uk/government/organisations/public-health-england
4. American Public Health Association (APHA): https://www.apha.org/
5. The National Institute of Mental Health (NIMH): https://www.nimh.nih.gov/
6. Healthy People 2030: https://healthypeople.gov/
7. Points of Light: https://www.pointsoflight.org/
8. VolunteerMatch: http://www.medicineandbeyond.org/boston%2C%2Bma%2C%2Busa.html
9. Idealist: https://www.idealist.org/en
10. Volunteer World: https://www.volnow.org/

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 3	Good Health and Well-being	Health camps, awareness programs
SDG 4	Quality Education	Experiential learning and skill development
SDG 5	Gender Equality	Women empowerment initiatives
SDG 11	Sustainable Cities and Communities	Community development and local engagement
SDG 13	Climate Action	Environmental awareness and protection programs

SDG 16	Peace, Justice and Strong Institutions	Civic responsibility and ethical citizenship

Course Code	Course Title	Total Credit	Credit Hours
VA16422	**Human Values and Professional Ethics**	**2**	**2-0-0**

Course Objectives:

To assist students in understanding the role of values and ethics in establishing a fair and equitable social order. To encourage students to inculcate human values and morals in their professional lives.

Course Learning Outcomes

CO1- Comprehend the implications of Human Values in one's life.

CO2- Understand the ideas of human values by discussion and explanation.

CO3- Apply the concepts and practices in their daily life.

CO4- Analyse the links between human values and professional ethics.

CO5- Evaluate and judge what to do and what not to do.

CO–PO-PSO Mapping Matrix using standard correlation levels:
3 = High, 2 = Medium, 1 = Low, – = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	1	2	3	2	1	3	2	1	2	2	3	2	2	3

CO2	3	3	2	3	3	2	1	3	2	2	2	2	3	2	2	3
CO3	3	3	3	2	3	2	2	3	2	3	2	3	3	2	3	3
CO4	3	3	3	3	3	3	2	3	3	3	2	3	2	2	3	3
CO5	3	3	3	3	3	3	2	3	3	3	2	3	2	2	3	3

Course Inputs:

UNIT I: Introduction of Human Values-

Need, fundamental guidance, content material and method for cost education: need of self-introspection, understand happiness and prosperity, approach to meet the human aspirations, information and dwelling in concord at numerous levels.

UNIT II: Introduction of Professional Ethics-

Basic concepts, personal and professional ethics, lifestyles skills, emotional intelligence, thought of ethics, value education, ethical development,work place- right and responsibilities.

Recommended Learning Resources:

Textbooks

1. Professional Ethics: R. Subramanian, Oxford University Press, 2015.

2. The Human Values: Dewan, M.L., Hosdurg, A. K., Nayak, P., Concept publishing company, New Delhi, 2009.

Reference Material & Digital Resources

e-PG-Pathshala

NMEICT/any other Government Initiatives

NPTEL Online Courses URL: https://nptel.ac.in/course.html

SWAYAM courses URL: https://swayam.gov.in/explorer

MOOC Courses URL: https://www.mooc.org/#course-categories

KISS LMS: :https://learn.kiss.ac.in

Note: Latest edition of the text books should be used.

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Promotes value-based education and ethical awareness

SDG 5	Gender Equality	Encourages equality and respect
SDG 8	Decent Work and Economic Growth	Promotes ethical workplace practices
SDG 10	Reduced Inequalities	Encourages fairness and inclusiveness
SDG 16	Peace, Justice and Strong Institutions	Promotes justice, ethics, and responsible citizenship

Course Code	Course Title	Total Credit	Credit Hours
VA16488	**Sports and Yoga**	**2**	**2-0-0**

Course Objectives

The course is designed to provide students with a fundamental understanding of Physical Education, Sports, and Yoga while promoting physical fitness, health, and overall well-being. It aims to develop basic knowledge and practical skills in physical activities, encourage discipline and teamwork, and inspire students to adopt a healthy lifestyle through regular participation in sports and yoga.

After successful completion of the course, students will be able to:

CO1: Explain the fundamental concepts and importance of Physical Education, Sports, and Yoga in promoting health and well-being.

CO2: Demonstrate basic physical fitness exercises, sports skills, and yoga practices for overall physical and mental development.

CO3: Apply the principles of health, fitness, nutrition, and wellness to maintain a healthy lifestyle.

CO4: Develop discipline, teamwork, leadership, sportsmanship, and ethical values through participation in physical activities and sports.

CO5: Adopt lifelong habits of regular physical activity and yoga to improve fitness, reduce stress, and enhance quality of life.

CO–PO–PSO Mapping Table

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	2	2	2	2	1	2	2	2	1	1	1
CO2	3	3	2	2	3	2	2	2	3	2	2	2	3	2	2	2
CO3	3	3	2	2	3	3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	3	2	2	3	3	3	3	3	2	3	2	2	2	3
CO5	2	3	2	2	3	3	3	3	2	2	3	3	2	2	3	3

Course Inputs:

Unit-I Introduction

1. Meaning and definition of Physical Education, Sports and Yoga.
2. Aims, Objectives and Importance of Physical Education, Sports and Yoga.
3. History of Physical Education, Sports and Yoga.
4. Modern trends of Physical Education, Sports and Yoga.
5. Brief concept of Education in relation to Physical Education, Sports and Yoga

Unit -II Yoga & Fitness Training

1. Importance of Yoga & Fitness
2. Fundamentals Principles of Yoga & Fitness Training
3. Components of Fitness and Fitness Equipments
4. Types of Yoga Practices - Asanas, Pranayama and Meditation
5. Introduction to Balanced Diet for Fitness

Reference Books

1. Bucher, C. A. (n.d.) Foundation of physical education. St. Louis: The C.V. Mosby Co. Deshpande, S. H. (2014). Physical Education in Ancient India. Amravati: Degree college of Physical education.

2. Mohan, V. M. (1969). Principles of physical education. Delhi: Metropolitan Book Dep. Nixon, E. E. & Cozen, F.W. (1969). An introduction to physical education. Philadelphia: W.B. Saunders Co.

3. William, J. F. (1964). The principles of physical education. Philadelphia: W.B. Saunders Co.

4. Coalter, F. (2013) Sport for Development: What game are we playing?.Routledge.

5. Singh Hardayal (1991), Science of Sports Training, DVS Publication, New Delhi 6. Muller, J. P.(2000). Health, Exercise and Fitness. Delhi : Sports.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 3	Good Health and Well-being	Promotes physical fitness and healthy lifestyle
SDG 4	Quality Education	Enhances experiential and skill-based learning
SDG 5	Gender Equality	Encourages inclusive sports participation
SDG 11	Sustainable Cities and Communities	Preserves traditional cultural practices
SDG 16	Peace, Justice and Strong Institutions	Promotes fairness, discipline, and teamwork

Course Code	Course Title	Total Credit	Credit Hours
VA16482	**Self-help and Happiness**	**2**	**2-0-0**

Course Objectives: This course aims to enable students to understand and address personal well-being by exploring topics like anxiety, stress, relationships, and happiness. The focus will be on practical strategies and interventions for improving mental health and fostering positive well-being. Students will also gain hands-on experience in measuring and managing stress, anxiety, and relationships through activity-based learning.

Course LearningOutcomes (COs)

CO1: Understand concepts of anxiety, stress, relationships, and happiness.

CO2: Apply strategies to manage anxiety and stress.

CO3: Analyze relationship dynamics and psychological well-being.

CO4: Develop techniques for improving happiness and emotional health.

CO5: Evaluate personal well-being and adopt self-improvement strategies.

CO–PO-PSO Mapping Table

1 = Weakly Mapped (Low) **2** = Moderately Mapped (Medium)

3 = Strongly Mapped (High) **"–"** = No correlation

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	3	2	1	3	3	2	1	2	3	2	2	2
CO2	3	3	3	3	3	2	2	3	2	3	2	3	3	3	2	3
CO3	3	3	3	3	3	2	2	3	2	3	2	2	2	3	3	2
CO4	3	2	3	3	3	3	1	3	2	3	2	3	2	2	2	3
CO5	3	3	3	3	3	3	2	3	2	3	2	3	2	3	2	3

Course Input:

Unit I: Understanding Mental Health and Well-Being (13 hours)

Anxiety, Nature, Types, Fear, Phobias (Generalized and Specific), Definition and nature of anxiety, Types of anxiety disorders, Overview of fear and phobias, Differences between generalized and specific phobias, Strategies for managing and reducing anxiety

Stress: Definition, Nature, Types, and Sources: Understanding stress and its nature, Types of stress (acute, chronic, etc.), Sources of stress (external and internal), Stress appraisal process, Effects of stress on psychological functioning and health, PTSD (Post-Traumatic Stress Disorder)

Relationships: Dynamics, Evolution, Transition, Integration, and Transformation: Understanding the nature of relationships, Dynamics in personal and professional relationships, The evolution of relationships over time, Key factors in relationship transitions and transformations

Happiness: Definition, Positive Well-being, and Dynamics: Defining happiness and well-being, An integrative look at happiness: psychological and physiological aspects, Understanding the dynamics of happiness in life, Positive psychology and strategies to increase happiness

Unit II: Activity-Based Practical Learning (17 hours)

Measurement of Anxiety and Strategies to Deal with Anxiety Attacks, Introduction to SCAT (Sinha's Comprehensive Anxiety Test), Administering and scoring SCAT, Activity: Catharsis (Emotional Unburdening), Practical strategies to cope with anxiety and fear

Overcoming Stress and Strategies to Handle Stress, Techniques for managing stress: relaxation exercises, time management, and mindfulness, Developing psychosocial support systems, Therapy methods: Art, music, and color therapy, Activity-Based Learning: Stress-reducing activities

Measurement of Relationships and Developing Healthy Relationships, Measuring relationship quality and communication, Role-playing for relationship-building: psychodrama and sociodrama, Activity: Practicing healthy communication and conflict resolution

Happiness: Body and Mind Coordination and Cognitive Behavioral Intervention, Cognitive-behavioral interventions to enhance happiness, Overcoming fear and anxiety through cognitive strategies, Activity: Increasing your own happiness through self-reflection

Recommended Learning Resources:

Textbooks

1. The Happiness Project, Gretchen Rubin, A comprehensive exploration of strategies for increasing happiness and well-being.
2. The Anxiety and Phobia Workbook, Edmund J. Bourne, A practical guide for understanding and managing anxiety disorders.
3. The Stress Management Handbook: Strategies for Health and Inner Peace , James W. Dazoul, Techniques and strategies to manage stress and improve psychological health.
4. The Art of Loving by Erich Fromm, A deep dive into the dynamics and psychology of relationships and love.

Reference Material & Digital Resources

1. The Power of Now, Eckhart Tolle, Understanding the importance of living in the present moment for well-being and happiness.
2. The Happiness Hypothesis by Jonathan Haidt, A psychological perspective on happiness, integrating science with personal experience.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 3	Good Health and Well-being	Promotes mental health, stress management, and emotional well-being
SDG 4	Quality Education	Encourages life skills and holistic learning
SDG 5	Gender Equality	Promotes equality in relationships and emotional awareness
SDG 10	Reduced Inequalities	Supports inclusive mental health awareness
SDG 16	Peace, Justice and Strong Institutions	Promotes harmony, emotional balance, and conflict resolution

Course Code	Course Title	Total Credit	Credit Hours
VA16430	Life Skills Education	2	2-0-0

Course Objectives:

• Enable students to understand core life skills , its concept, process and practice • Apply life skills to cope with the demands and challenges in day to day life • Explore alternatives and make rational decisions in solving each problem or issue • Enable students to manage Sexual and Reproductive Health (SRH) concerns • Develop understanding on the life cycle of girl child

Course Learning Outcomes:

CO1: Understand concepts and importance of life skills.

CO2: Apply life skills to cope with daily challenges.

CO3: Analyze social norms, gender issues, and health concerns.

CO4: Develop decision-making and problem-solving abilities.

CO5: Evaluate personal behavior and adopt responsible practices.

CO–PO-PSO Mapping Table

1 = Weakly Mapped (Low) **2** = Moderately Mapped (Medium)

3 = Strongly Mapped (High) **"–"** = No correlation

COs ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1	1	2	2	1	2	2	1	2	2	2	1	1	2
CO 2	2	2	3	2	3	3	2	3	2	2	2	3	3	2	2	3
CO 3	2	3	2	2	3	2	2	3	2	2	2	2	3	2	1	3
CO 4	2	2	3	2	3	3	2	3	2	3	2	3	3	3	2	3
CO 5	2	3	2	3	3	2	2	3	2	3	2	3	3	2	2	3

Course Input:

Unit- I Introduction to Life Skills (17 lectures)

Concept of Skills and Life Skills • Definition and importance of life skills • Ten core Life skills (WHO model) • Life Skills Education, Life Skills Approach, Life Skills Based Education, Social Skills, Self Awareness(Self concept, Self Confidence, Techniques used for knowing self : Open your heart, SWOT analysis, Johari window) • Empathy (Meaning of empathy, differences between sympathy and empathy) • Effective Communication(components of effective communication, Styles of communication, Barriers in communication, How to say NO) • Interpersonal Relationship(Meaning, types ,qualities for effective interpersonal relationship, end the relationship constructively), Thinking Skills and Coping Skills **,** Critical thinking and Creative thinking (Definition and Stages) • Problem solving and Decision making (Definition, Steps in problem solving and decision making, Models of decision making) • Meaning and types of emotions, coping strategies • Meaning and sources of stress, coping strategies, Life Skills Education for enhancing value of the girl child, Survival of girl child,

Unit II: Social norms (13 lectures)

Barrier to survival Lack of access and control over resources Policies, schemes, programs related to foeticide, Puberty and Marriage, Health and Reproductive health (Definition, Communicable diseases, Reproductive health issues) Life Skills for responsible sexual behavior Menstrual hygiene and care Institutional barriers for awareness, myth busting around menstruation and sanitation Schemes and programs related to menstruation Marriage and evolving gender roles Acts and Laws related to marriage includes laws on PMCA and POCSO as well as Sexual Harassments at workplace • Negligence of girl child and Violence Gender inequalities in curative and preventive health care (Anaemia, Malnutrition and stunting) Gender norms affecting education Discriminatory gender biased norms & practices Acts and Laws related to: Gender Based Violence, domestic violence, Dowry & dowry death Early Pregnancy and its prevention Motherhood Penalty & Concretization of Patriarchal Norms Course Outcomes (COs)

Recommended Learning Resources:

Textbooks

1. Dahama O.P., Bhatnagar O.P, (2005), Education and Communication for Development, (2nd Edn.), Oxford& IBH Publishing Co. Pvt. Ltd. New Delhi.

2. Duffy Grover Karen, Atwater Eastwood, (2008), (8th Edn.), Psychology for Living- Adjustment, Growth and Behaviour Today, Pearson Education Inc, New Delhi.

3. Jane S Halonen, John W. Santrock, (2009), Psychology: Context & Application, McGraw-Hill Companies Inc., Third Edition, USA

4. Mangal S.K., (2008), An Introduction to Psychology, Sterling Publishers Pvt. Ltd., New Delhi.

5. Nair .V. Rajasenan, (2010), Life Skills, Personality and Leadership, Rajiv Gandhi National Institute of Youth Development, Tamil Nadu.

6. Nair. A. Radhakrishnan, (2010), Life Skills Training for Positive Behaviour, Rajiv Gandhi National Institute of Youth Development, Tamil Nadu.

Reference Material & Digital Resources

1) Nair. V.Rajasenan,(2010),Life Skills, Personality and Leadership,Rajiv Gandhi National Institute of Youth Development,Tamilnadu

2) RGNIYD (2008) Facilitators Manual on Enhancing Life Skills,Tamilnadu

3) Family Health International, NACO,USAID(2007),LifeSkills Education tool kit for Orphans and vulnerable children in India

4) Morgan and King,(1993) Introduction to Psychology, Tata McGraw-Hill Publishing Company Ltd,New Delhi.

5) Wallace R. M.asters,(2001) Personal Development for Life and Work: UK,South Western

6) Adolescence and Life Skills (2003) Commonwealth Youth Programme Asia Centre,Tata Mc Graw. Hill Websites:

UNFPA-http://www.unfpa.org/ ü UNICEF-http://www.unicef.org/ ü WHO –http://www.who.int./en/ ü Jhpiego - https://www.jhpiego.org/countries-we-support/india/

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 3	Good Health and Well-being	Promotes mental, emotional, and reproductive health awareness
SDG 4	Quality Education	Enhances life skills and holistic learning
SDG 5	Gender Equality	Focus on gender issues, girl child development, and equality

SDG 10	Reduced Inequalities	Addresses social and gender inequalities
SDG 16	Peace, Justice and Strong Institutions	Encourages responsible and ethical behavior

SEMESTER-3

Course Code	Course Title	Credits			Total Credits
		L	T	P	
BR20001	Wind Energy	3	0	1	4

Prerequisite: Students should have a foundational understanding of renewable energy systems and basic physics concepts including motion, force, pressure, air flow, and energy conversion. Familiarity with environmental science and weather-related concepts will support understanding of wind regimes and turbine operation.

Course Objective:

To provide fundamental knowledge on wind energy resources, conversion principles, and wind data analysis for effective utilization in energy systems.

Course Outcomes (COs)

CO1: Explain the fundamentals, history, and applications of wind energy systems.
CO2: Analyze wind characteristics, wind regimes, and energy estimation methods.
CO3: Describe aerodynamic principles and rotor performance of wind turbines.
CO4: Apply concepts of wind energy conversion systems and grid integration.
CO5: Evaluate the performance of wind generators, pumps, and safety mechanisms.
CO6: Assess environmental and economic aspects of wind energy systems.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	2	2	1	-	-	-	-	1	1	2	3	1	1	-	-
CO2	-	3	2	3	3	2	1	-	2	-	2	2	3	2	3	2	-
CO3	-	3	1	3	2	-	-	1	-	3	2	1	3	3	2	2	-
CO4	1	3	2	3	3	-	-	-	-	-	3	2	3	3	2	3	-
CO5	-	3	1	2	3	2	-	-	1	-	3	2	2	3	3	2	3
CO6	2	3	2	3	2	2	-	-	1	-	2	3	2	2	3	2	3
Avg.	0.66	3	1.6	2.66	2.33	1	0.16	0.16	0.66	0.66	2.16	2	2.66	2.33	2.33	1.66	1

Course Contents

Unit 1:- **Basics of Wind Energy Conversion (12 Hours)**

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

Unit 2: - Aerodynamics of wind turbine (10 Hours)

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

Unit 3: - Wind energy conversion systems: (8 Hours)

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

Unit 4:- Wind Energy and Environment: (10 Hours)

Environmental benefits and problems of wind energy Economics of wind energy: Factors influencing the wind energy economics- Site specific parameters-machine parameters- Life cycle cost analysis.

Link:https://www.youtube.com/watch?v=Q1uedC-1gko
https://www.youtube.com/watch?v=Joo3nCMRmkM

Text Book

Johnson GL. Wind Energy Systems, (Electronic Edition), Prentice Hall Inc, 2006

Reference Book: -

1. Burton T. Sharpe D. Jenkins N. Bossanyi E. Wind Energy Handbook. John Wiley, 2001
2. Jha AR. Wind Turbine Technology, CRC Press, Taylor & Francis, 2011
3. Jain P. Wind Energy Engineering. McGraw-Hill 2011

PRACTICAL

1. **Study the basic components of a wind energy system.**
2. **Study different types of wind turbines.**
3. **Study wind speed measurement using an anemometer.**
4. **Study voltage generation from a small wind turbine.**
5. **Study basic safety measures in wind energy systems.**

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Wind energy generation and renewable power systems
8	Decent Work and Economic Growth	Skill development in wind energy technologies
9	Industry, Innovation and Infrastructure	Wind turbine design and grid integration
11	Sustainable Cities and Communities	Clean and sustainable electricity generation
13	Climate Action	Reduction of greenhouse gas emissions through wind energy

Course Code	Course Title	Credits			Total Credits
		L	T	P	
BR20003	Electrical Measurement and Electronic Instruments	3	0	0	3

Prerequisite: Students should possess basic knowledge of electrical circuits, measuring units, and electronic devices. Familiarity with voltmeters, ammeters, multimeters, and elementary electronic circuit concepts will help students understand measurement techniques and instrumentation systems.

Course Objective (COB):

To develop an understanding of the principles, methods, and instruments used in electrical measurement, and to analyze their applications for accurate testing, calibration, and system monitoring.

Course Outcomes (COs)

CO1: Recall the working principles and construction of various electrical and electronic measuring instruments.

CO2: Understand different measurement techniques to determine electrical parameters such as current, voltage, power, resistance, and energy.

CO3: Examine the performance, errors, and limitations of analog and digital measurement systems.

CO4: Evaluate the suitability of different instruments for specific engineering applications.

CO5: Analyze the testing, and calibration purposes.

CO-PO-PSO Mapping

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	1	3	2	1	-	-	-	-	-	-	2	-	2	2	1	-	-
CO 2	-	3	2	2	3	-	-	-	-	1	2	-	2	3	2	-	-
CO 3	1	3	-	3	2	2	-	1	-	-	2	-	2	3	2	2	-
CO 4	-	3	-	3	3	2	-	-	-	-	3	-	2	3	3	2	2
CO 5	1	2	-	2	1	-	1	-	-	-	-	1	1	2	1	-	-

Avg	0.6	2.8	0.8	2.2	1.8	0.8	0.2	0.2	-	0.2	1.8	0.2	1.8	2.6	1.8	0.8	0.4

Course Contents

Unit 1 : (12 Hours)

Measurement Error, Accuracy and Instrument grades , Electromechanical instruments, Electromechanical instruments (contd.) , Electromechanical ammeters, voltmeters and ohmmeters

Unit 2 : (12 Hours)

Electromechanical wattmeter and energy meter, Resistance Measurement ,Impedance Measurement: AC Bridges, Impedance Measurement: AC Bridges (contd.) , Potentiometers: DC and AC , Instrument transformers: CT & PT ,Magnetic Measurement

Unit 3 : (6 Hours)

Analog Instrumentation Basics, Analog Instrumentation Basics(contd.) ,Analog Instrumentation

Unit 4 : (10 Hours)

Digital Instrumentation Basics , Digital Instrumentation, Signal and Function Generators, Oscilloscope and Electronic probes

Text Books

1. Electronic Instrumentation and Measurements: David A. Bell
2. A course in Electrical and Electronic Measurements and Instrumentation: A. K. Sawhney

References Books

1. Basic Electrical Measurements: M B Stout
2. Electrical Measurements and Measuring Instruments, E.W Golding, F.C Widdis
3. Part I: Electrical Measurements: Chapter wise study material
4. Part II: Electronic Instruments: Chapter wise study material

Link for Course:- https://onlinecourses.nptel.ac.in/noc25_ee123/preview

SDG Mapping

SDG	Title	Contribution
4	Quality Education	Development of technical knowledge in measurement systems
7	Affordable and Clean Energy	Monitoring and optimization of electrical systems
8	Decent Work and Economic Growth	Instrumentation and testing skill enhancement
9	Industry, Innovation and Infrastructure	Advanced measurement and calibration technologies
12	Responsible Consumption and Production	Accurate measurement for efficient resource utilization

Course Code	Course Title	Credits			Total Credits
		L	T	P	
BR20005	Advanced Renewable Energy Sources	2	1	0	3

Prerequisite: Students should have prior knowledge of conventional and renewable energy systems including solar, wind, hydro, and biomass energy. Basic understanding of energy conversion principles, thermodynamics, and electrical fundamentals is recommended.

Course Objective:

To impart knowledge on emerging energy systems such as hydrogen, fuel cells, ocean, geothermal, and magneto-hydrodynamic technologies along with modern storage methods.

To develop analytical skills for evaluating production, conversion, and storage processes for sustainable power applications.

Course Outcomes (COs):

CO1: Explain hydrogen energy production, storage, transportation, and applications.

CO2: Describe the working principles and classifications of fuel cells and batteries.

CO3: Apply thermodynamic and electrochemical principles in energy conversion systems.

CO4: Analyze ocean, tidal, wave, geothermal, and MHD energy conversion technologies.

CO5: Evaluate advanced energy storage systems including SMES, capacitors, and supercapacitors.

CO6: Assess emerging renewable energy technologies for sustainable power generation applications.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	2	-	-	-	-	1	3	-	-	-	1
CO2	3	3	2	-	2	-	-	-	-	-	-	-	3	2	-	-	-
CO3	3	3	-	2	2	-	-	-	-	1	-	-	-	3	-	-	-
CO4	3	3	3	2	-	-	3	-	-	-	1	-	3	-	2	-	2
CO5	-	3	-	2	3	-	2	-	-	-	-	2	-	3	3	-	-

CO6	-	-	3	-	-	2	3	2	-	-	2	3	-	-	3	2	2
Avg	2	2.33	1.33	1	1.16	0.33	1.7	0.33	-	0.16	0.5	0.83	1.5	1.33	1.33	0.33	0.83

Course Contents

Unit 1: - Hydrogen Energy: (9 Hours)

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

Unit 2: - Fuel Cell: (12 Hours)

Principle of working -Basic thermodynamic and electrochemical principles – Classifications-Applications for power generations Electrochemical Energy Storage System: Batteries – Types - Working principles - Role of carbon nanotubes in electrode.

Unit 3: - Ocean Energy: (10 Hours)

Ocean energy resources - Ocean energy routes -Ocean thermal energy conversion - Wave energy conversion - Tidal energy conversion Geothermal Energy: Origin - Types of geothermal energy sites - Geothermal Power plants.

Unit 4: - Magnetohydrodynamic (MHD) energy conversion: (9 Hours)

Principle of operation - Classifications - Features of MHD Systems Magnetic and Electric Storage System: Super conducting magnetic energy storage (SMES) systems - Capacitor and super capacitor

References Books

Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012;
First Edition.; S. Chand & Company Ltd.
https://www.youtube.com/watch?v=l1pxV7Nro34

1.

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Advanced renewable and hydrogen energy systems
9	Industry, Innovation and Infrastructure	Emerging technologies in energy conversion and storage
11	Sustainable Cities and Communities	Sustainable and smart energy applications
12	Responsible Consumption and Production	Efficient energy storage and utilization
13	Climate Action	Clean advanced energy technologies reducing environmental impact

Course Code	Course Title	Credit			Total Credit
		L	T	P	
BR20007	Practical Implementation to Arduino UNO	1	0	1	2

Prerequisite: Students should have prior knowledge of programming,software and computer.

Course Objective:

To impart knowledge on Arduino UNO along with practical Implementation.

To develop analytical skills for execution and practical application processes for sustainable power applications project work.

Course Objective (COB):

To provide hands-on knowledge of Arduino UNO for implementing basic electronic circuits, sensors, and automation projects.

Course Outcomes (COs):

CO1: Understand Arduino programs to control sensors, actuators, and peripheral devices.

CO2: Examine and troubleshoot Arduino-based circuits and interfacing issues.

CO3: Assess the efficiency and performance of Arduino applications in various domains.

CO4: Evaluate the practical implementation of Arduino UNO for real-world programme.

CO5: Design and implement innovative projects using Arduino UNO for real-world problem solving.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	2	-	-	-	-	1	2	-	-	-	-
CO2	3	3	2	-	2	-	-	-	-	1	-	-	3	2	-	-	1
CO3	2	2	2	1	-	-	2	-	-	-	-	-	-	3	2	-	3
CO	-	3	3	2	2	-	3	-	-	-	1	-	2	-	3	-	-

4																	
CO 5	3	3	3	-	3	2	3	-	-	-	2	2	3	3	3	2	1
Avg	2.2	2.6	2	0.6	1.4	0.4	2	-	-	0.2	0.6	0.6	2	1.6	1.6	0.4	1

Course Contents

Unit 1: Introduction to Arduino UNO [10 hrs]
Overview of Arduino UNO board and IDE
Pin functions (digital, analog, power)
Writing and uploading first program (Blink LED)
Unit 2: Basic Input/Output Programming [10 hrs]
Digital input and output (LEDs, switches, buzzer)
Analog input (potentiometer, LDR)
PWM basics for brightness/speed control
Unit 3: Sensor and Actuator Interfacing [10 hrs]
Temperature sensor, IR sensor, ultrasonic sensor (basic use)
Motor and relay control (ON/OFF and speed variation)
Small practice tasks (automatic light, fan control, distance measurement)
Unit 4: Mini Projects with Arduino UNO [10 hrs]
Combining sensors and actuators in small projects
Examples:
Automatic street light
Obstacle detection with buzzer
Temperature-controlled fan

SDG Mpping

SDG	Title	Contribution
4	Quality Education	Hands-on learning in embedded systems, coding, and automation
7	Affordable and Clean Energy	Development of energy-efficient automation projects
8	Decent Work and Economic Growth	Skill enhancement in Arduino programming and electronics prototyping
9	Industry, Innovation and Infrastructure	Innovation in IoT, automation, and smart device applications
11	Sustainable Cities and Communities	Smart systems like automatic street lighting and monitoring
12	Responsible Consumption and Production	Efficient use of sensors and automated energy management
13	Climate Action	Sensor-based energy conservation and sustainable automation technologies

Code	Course Title	Credit	L – T – P
CS23001	**Introduction to Artificial Intelligence and Machine Learning**	**3**	**2-0-1**

Course Learning Objective: Develop a foundational understanding of AI and ML concepts, algorithms, and applications to improve decision-making and problem-solving in a business context.

Course Learning Outcomes: On completion of this course, the students should be able to:

CO1:Understand the fundamental concepts of Artificial Intelligence, Machine Learning, intelligent agents, and their relevance in business and management contexts.

CO2:Apply supervised and unsupervised machine learning techniques such as regression, classification, and clustering for solving business problems.

CO3:Analyze the application of machine learning in functional areas like marketing, finance, and operations for data-driven decision-making.

CO4:Evaluate ethical issues related to AI and ML, including bias, transparency, accountability, and their impact on society and employment.

CO5:Examine emerging trends in AI and ML (such as deep learning, NLP, and computer vision) and assess their potential for innovation and business strategy.

CO–PO Mapping Matrix

(3 = High, 2 = Medium, 1 = Low, – = No correlation)

COs ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	2	2	3	2	1	2	2	2	3	2	3	2	2	2
CO 2	3	3	3	3	3	2	2	3	2	2	3	2	3	3	2	3
CO 3	3	3	3	3	3	3	2	3	2	3	3	2	3	3	3	3
CO 4	3	3	2	2	3	3	1	3	3	2	2	3	3	2	2	3
CO 5	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3

Course Inputs:

Unit 1: Introduction to Artificial Intelligence [9 Classroom Contact Hours]

What is AI? History and philosophical foundations, Intelligent agents and problem-solving approaches in AI, Applications of AI in various industries. (Case studies relevant to Management)

Unit 2: Introduction to Machine Learning [9 Classroom Contact Hours]

Supervised learning: Regression and Classification algorithms (Linear Regression, Decision Trees), Unsupervised learning: Techniques for data exploration and clustering (K-Means clustering, Principal Component Analysis), Model evaluation metrics for supervised and unsupervised learning.

Unit 3: Applications of Machine Learning in Management [9 Classroom Contact Hours]

Machine Learning in Marketing: Customer segmentation, targeted advertising, and recommendation systems, Machine Learning in Finance: Fraud detection, credit risk assessment, and algorithmic trading, Machine Learning in Operations: Supply chain management, demand forecasting, and resource optimization.

Unit 4: Ethical Considerations and Societal Impact of AI and ML [9 Classroom Contact Hours]

Algorithmic bias and fairness in AI and ML systems, Explain ability and transparency of AI and ML models, The future of work and job displacement due to AI and ML.

Unit 5: Future Trends and Business Opportunities in AI and ML [9 Classroom Contact Hours]

Emerging areas in AI and ML: Deep Learning, Natural Language Processing, Computer Vision, The role of AI and ML in business strategy and innovation.

Readings:

- Articles on recent advancements and business applications of AI and ML (chosen by instructor).

Reference Books:

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig. [Pearson Education]
2. Machine Learning for Dummies by John Paul Mueller & Luca Massaron. [Wiley]
3. Hands-On Machine Learning with Scikit-Learn,

SDG Mapping for this Course

SDG	Title	Contribution
4	Quality Education	AI awareness for nonCS students
8	Decent Work and Economic Growth	Future skill orientation
9	Industry, Innovation and Infra	Intelligent systems overview
10	Reduced Inequalities	Using / critiquing AI for inclusion
13	Climate Action	Examples: precision agri, climate models

Course Type	CODE	Title		
Ability Enhancement Course	**AE24001**	**Communicative English**	**2-0-0**	**2**

Course Objectives: After completing this course, learners will be able to:

- Understand the concepts, principles, types, and importance of communication in academic, social, and professional contexts.
- Develop effective verbal and non-verbal communication skills by understanding communication processes, barriers, and strategies for successful interaction.
- Enhance reading, listening, speaking, and writing skills through comprehension exercises, group discussions, presentations, and language practice.
- Acquire professional writing skills by preparing CVs, résumés, summaries, notes, compositions, and other functional documents.
- Build confidence, interpersonal skills, critical thinking, and employability through effective communication and collaborative learning activities.

Course Outcomes:

CO1:Explain the concepts, types, functions, and barriers of communication and apply appropriate communication strategies in different contexts.

CO2:Demonstrate effective verbal and non-verbal communication skills by using suitable language, body language, and listening techniques in interpersonal and professional interactions.

CO3:Apply reading comprehension strategies and critical thinking skills to understand, interpret, and evaluate different types of texts.

CO4:Produce clear, coherent, and professional written communication by preparing summaries notes, compositions, information transfer exercises, CVs, and résumés.

CO5:Demonstrate confidence and competence in speaking, group discussions, presentations and conversational English for academic and workplace communication.

Course Outcomes - Programme Outcomes Mapping of Paper

CO ↓ / PO →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	3	2	2	3	2	2	2	3	2	3	3	3	3
CO2	2	3	3	3	3	3	2	3	2	2	3	3	2	3	3	3	3
CO3	2	3	3	3	3	3	2	3	3	2	3	3	2	3	3	3	3
C04	3	3	3	3	2	2	2	1	2	3	2	3	3	3	3	3	2
CO5	2	2	2	3	3	3	3	3	2	2	2	3	2	2	2	3	3

Course Contents:

1. What is Communication? Definition and Elaboration, Types of Communication:Horizontal/Vertical/Interpersonal/Grapevin. Uses of Communication

2. Verbal Communication: Spoken/Written

   Non-Verbal Comm: Proxemics/Kinesics/Haptics/Chronemics/Para Linguistics Barriers/ Noise

3. Reading Comprehension

4. Writings: Expansion/Notes & Summary/Information Transfer/ Composition/CV & Resume

5. Language Function in Listening & Conversation, Speaking on a Topic Group Discussion

Recommended Learning Resources

1. Dr. A. Ganeshan & P. Lovely Viniliya Pual: *Communicative English*, Charulata Publications.
2. Clampitt, Phillip G. *Communicating for Managerial Effectiveness*. Sage Publications, 2012.

3. Adler, Ronald B., and George Rodman. *Understanding Human Communication*. Oxford University Press, 2015.
4. Peters, Robert. *English Reading Comprehension Skills for Business*. Cambridge University Press, 2018.
5. Rao, P.K. *Business Communication*. Himalaya Publishing, 2017.
6. Adler, Ronald B., *Communicating at Work: Principles and Practices for Business and the Professions*. McGraw-Hill, 2012.
7. Locker, Kitty O., and Donna Kacz.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops communication competence, language proficiency, and employability skills
SDG 5	Gender Equality	Promotes inclusive and gender-sensitive communication
SDG 8	Decent Work & Economic Growth	Enhances professional communication for workplace readiness
SDG 9	Industry, Innovation & Infrastructure	Encourages digital communication and modern workplace tools
SDG 16	Peace, Justice & Strong Institutions	Promotes ethical communication, transparency, and responsible discourse

Skill Enhancement Course	**EC25001**	**Elementary Computer Application in Presentation of Data**	**2**	**0**	**1**	**3**

Course Objectives: To introduce the fundamentals of computer systems, hardware, software, and IT.
To develop basic digital skills for academic and economic applications.
To prepare students for handling data, documents, and presentations effectively.
Course Outcomes: After completion, the student will be able to:
CO1: Understand the basics of computer hardware, software, and operating systems.
CO2: Apply fundamental IT concepts to academic and economic data.
CO3: Use word processing, spreadsheet, and presentation tools for economic tasks.
CO4: Demonstrate awareness of digital resources, databases, and safe internet practices.
CO5: Evaluate the real time problem that arises with the computer application.

CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	
CO1	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-	2	-
CO2:	-	1	-	2	-	-	2	1	-	-	-	-	-	-	1	2	1

CO3:	-	-	-	-	-	-	3	-	1	2	-	-	-	-	-	3	1
CO3	2	-	-	-	-	-	2	-	-	-	2	1	-	-	-	2	-
CO5	-	-	-	2	-	-	2	-	-	-	-	2	-	-	-	2	-

Course Contents

Unit 1: Fundamentals of Computers and IT (15 hours)

Basics of Computers: Characteristics, Applications in Economics, Generations of Computers. Computer Components: Hardware (Input, Output, Storage devices), Software (System & Application).

Unit 2: Operating Systems (10 hours)

Windows/Linux basics, File management. Networking & Internet: Basics of LAN, WAN, Internet, Cloud Computing.ICT in Economics: Use of e-resources, databases (RBI, NSSO, World Bank, IMF).Digital Literacy: Cyber security, plagiarism, responsible use of information.

Unit 3: Office Productivity Tools & Data Handling (15 hours)

Word Processing (MS Word/Google Docs): Formatting, tables, inserting images, citations, preparing academic/economic reports.Spreadsheets (MS Excel/Google Sheets): Data entry, formulas, functions, charts, sorting & filtering economic data, basic statistics (mean, median, correlation).Presentation Tools (MS PowerPoint/Google Slides): Creating slides, charts, and visualizations for economic reports.

Practical Exercises: Drafting an economics report in Word. Analyzing GDP/inflation data in Excel. Presenting findings in PowerPoint.

Textbooks

1. **"Computer Fundamentals" – P.K. Sinha & Priti Sinha**
2. **"Fundamentals of Computers" – V. Rajaraman**

Reference Books

1. **"Computer Fundamentals and Programming in C" – Reema Thareja**
2. **"Introduction to Computers" – Peter Nortonl**
3. **"Microsoft Office 365 & Office 2019 Step by Step" – Joan Lambert & Curtis Frye**

SDG Mapping

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops foundational digital literacy, academic data-handling skills, and computer application competencies required for technical research and continuous learning in energy technologies.
SDG 7	Affordable and Clean Energy	Supports the renewable energy sector by enabling students to analyze economic data, track performance metrics, and model project feasibility using spreadsheet and presentation tools.
SDG 8	Decent Work and Economic Growth	Enhances workforce readiness and green-job employability by building high-demand skills in office automation, data presentation, and practical IT problem-solving.

SDG 9	Industry, Innovation and Infrastructure	Fosters technological capability and innovation by training students to manage hardware-software environments and evaluate real-time application errors in modern digital infrastructure.
SDG 12	Responsible Consumption and Production	Promotes paperless workflows, electronic reporting, and digital data management, optimizing resource utilization and minimizing physical material waste in academic and industrial practices.
SDG 16	Peace, Justice and Strong Institutions	Encourages cybersecurity compliance, data privacy, and the ethical retrieval of information by educating students on safe internet practices and authentic digital database usage.

SEMESTER- 4

Course Code	Course Title	Credits			Total Credits
		L	T	P	
BR20002	Energy Storage Systems	3	1	0	4

Prerequisite: Students should have basic understanding of renewable energy systems, electrical circuits, batteries, and energy conversion principles. Familiarity with concepts of power, voltage, charging, and thermal systems is desirable**.**

Course Objective: -

To provide an in-depth understanding of different energy storage technologies and their applications in sustainable energy systems.

To enable students to analyze, compare, and evaluate storage systems for efficiency, feasibility, and integration with renewable energy sources.

Course Outcomes (COs)

CO1: Explain different energy storage systems and their applications.

CO2: Analyze electrochemical, electrical, and magnetic energy storage systems.

CO3: Apply sensible heat storage techniques in thermal systems.

CO4: Evaluate latent heat thermal energy storage systems and PCM applications.

CO5: Assess energy storage technologies for renewable energy integration and sustainability.

CO-PO-PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-
CO 2	3	3	2	-	2	-	-	-	-	-	-	-	3	2	-	-	-
CO 3	3	3	-	2	3	-	-	-	-	1	-	-	-	3	2	-	2
CO 4	-	-	3	2	3	-	-	-	1	-	1	-	-	3	-	2	-
CO 5	-	-	3	-	3	2	2	-	-	2	2	2	3	3	3	2	3
Avg	1.8	1.6	1.6	0.8	2.2	0.4	0.4	-	0.2	0.6	0.6	0.4	1.6	2.2	1	0.8	1

Course Contents

Unit 1:- Energy Storage Systems

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

Unit 2:- Electrochemical, electrical and magnetic energy storage systems

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

Unit 3:- Sensible heat storage (SHS)

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

Unit 4:- Latent Heat Thermal Energy Storage (LHTES)

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

Text Book

Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

Reference Books:-

1. Solar Thermal Energy Storage; H.P. Garg, S.C. Mullick and A. K. Bhargava; 1985; Springer
2. Handbook of batteries; David Linden& Thomas B. Reddy; 2002; Third Edition; McGraw-Hill Companies, Inc. Energy Storage; Robert A. Huggins; 2010; Springer
3. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Efficient renewable energy storage systems
9	Industry, Innovation and Infrastructure	Advanced battery and storage innovations
11	Sustainable Cities and Communities	Grid stability and smart storage solutions
12	Responsible Consumption and Production	Sustainable battery lifecycle management
13	Climate Action	Enhancing renewable penetration and reducing carbon emissions

Course Code	Course Title	Credit Structure			Total
		L	T	P	
BR20004	Sensors and its Application	3	1	0	4

Prerequisite: Students should possess basic knowledge of electronics, transducers, electrical measurements, and instrumentation systems. Familiarity with electrical signals, basic circuit components, and control concepts will help in understanding sensor technologies and applications.

Course Objective (COB):

Acquire knowledge about the principles and analysis of sensors, emphasis on characteristics and response of micro sensors, acquire adequate knowledge of different transducers and actuators, learn about the Micro sensors and Micro actuators, selection of sensor materials for fabrication for different applications

Course Outcomes (COs):

CO1: Explain the fundamentals, classifications, and characteristics of sensors and transducers.
CO2: Identify temperature, force, torque, and pressure sensors for engineering applications.
CO3: Analyze displacement, level, and flow sensing techniques and their working principles.

CO4: Evaluate the performance and applications of smart sensors in automation systems.

CO5: Apply sensor selection and smart sensing concepts for industrial and renewable energy applications.

CO-PO-PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	-	-	-	1	3	-	-	-	-	2	2	-	2	-	2
CO 2	3	3	2	-	3	-	-	-	-	-	1	-	3	2	-	-	-
CO 3	3	3	3	2	2	-	2	-	-	-	-	-	3	3	2	-	-
CO 4	-	2	3	-	2	2	3	-	-	1	-	-	-	-	3	2	-
CO 5	-	3	-	2	-	3	3	2	-	-	-	2		-	3	2	2
Avg	1.8	2.6	1.6	0.8	1.4	1.2	2.2	0.4	-	0.2	0.2	0.8	1.6	1	2	0.8	0.8

Course Contents

Unit 1:- Fundamentals of Sensors: (12 hours)

Discuss sensor, transducer and Actuators- Classification of sensors: Proprioceptive and Exteroceptive – Active and Passive– Contact and Non-contact, selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, Primary sensing elements. Temperature sensors: Principle of operation, construction details, characteristics and applications of Bimetallic thermometer, Resistance thermometer, Thermistor, Thermocouples and Total radiation Pyrometers

Unit 2:- Classification of Sensor: (9 hours)

Strain, Force, Torque and Pressure Sensors Strain gauges, strain gauge beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezoresistive and capacitive pressure sensor, Manometer, vacuum sensors, Pirani gauge.

Unit 3 :- Displacement, Level and Flow Sensors Displacement Sensors: (12 hours)

LVDT, RVDT, eddy current, transverse inductive, Hall Effect, magneto resistive, magneto strictive sensors. Liquid level sensor: Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. Flow sensors: pressure gradient technique, ultrasonic, electromagnetic sensors and Hot wire anemometer. Micro flow sensor, Coriolis mass flow and drag flow sensor.

Unit 4:- Smart Sensors: (7 hours)

General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.

Text Book

1. DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013
2. D Patranabis, Sensors and Transducers, PHI 2nd Edition 2013.
3. Gupta, J.P. Gupta / PC interfacing for Data Acquisition & Process Control, 2nd ED / Instrument Society of America, 1994.
4. Gary Johnson / Lab VIEW Graphical Programing II Edition / McGraw Hill 1997.

Reference Books:

1. Arun K. Ghosh, Introduction to measurements and Instrumentation, PHI, 4th Edition 2012.
2. A.D. Helfrick and W.D. cooper, Modern Electronic Instrumentation & Measurement Techniques, PHI – 2001
3. Hermann K.P. Neubert, “Instrument Transducers” 2nd Edition 2012, Oxford University Press.

SDG Mapping

SDG	Title	Contribution

4	Quality Education	Advanced sensing and instrumentation knowledge
7	Affordable and Clean Energy	Sensors in renewable monitoring systems
9	Industry, Innovation and Infrastructure	Smart automation technologies
11	Sustainable Cities and Communities	Intelligent sensing systems
13	Climate Action	Environmental and industrial monitoring

Course Code	Course Title	Credits			Total Credits
		L	T	P	
BR20006	Energy Conservation Techniques	3	1	0	4

Prerequisite: Students should possess basic knowledge of energy, measurements, and conservation systems. Familiarity with electrical conservation concepts will help in understanding technologies and applications.

Course Objective (COB):

To provide knowledge of energy conservation principles, methods, and applications in electrical, thermal, and building systems for sustainable development.

Course Outcomes (COs):

CO1: Explain the principles, policies, and importance of energy conservation and waste minimization.

CO2: Analyze energy conservation methods used in electrical systems and equipment.

CO3: Apply thermal energy conservation techniques in boilers, furnaces, and steam systems.

CO4: Evaluate energy-efficient technologies used in residential and commercial buildings.

CO5: Assess sustainable energy conservation practices for environmental protection and resource management.

CO-PO-PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	-	-	-	1	3	-	-	-	-	2	2	-	2	-	-
CO 2	3	3	2	-	3	-	-	-	-	-	1	-	3	2	-	-	2
CO 3	3	3	3	2	2	-	2	-	-	-	-	-	3	3	2	-	3
CO 4	-	2	3	-	2	2	3	-	-	1	-	-	-	-	3	2	3
CO 5	-	3	-	2	-	3	3	2	-	-	-	2	-	-	3	2	-
Avg	1.8	2.6	1.6	0.8	1.4	1.2	2.2	0.4	-	0.2	0.2	0.8	1.6	1	2	0.8	1.6

Course Contents

Unit 1:- Introduction (10 hour)

Energy conservation & its importance - The Energy conservation Act 2001 & its features Waste Minimization & Resource Conservation, Need of waste minimization - Waste minimization method & its classification - Effects of waste environment & Role of pollution control board - Case study.

Unit 2:- Energy Conservation Methods in Electrical System (12 hour)

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

Unit 3 :- Energy Conservation in Thermal System (12 hour)

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

Unit 4:- Energy Conservation in Housing & Commercial Building (8 hour)

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

Text Book

Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press

References Books

1. Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, New Delhi
2. Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M. Dekker , www.bee-india.com
3. Energy Efficiency in Thermal Utilities, 2010, BEE guide book

1.

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Efficient energy utilization practices
9	Industry, Innovation and Infrastructure	Energy-efficient industrial systems
11	Sustainable Cities and Communities	Green building and smart housing solutions
12	Responsible Consumption and Production	Resource conservation methods

13	Climate Action	Reducing emissions through efficiency

Course Code	Course Title	Credits			Total Credits
		L	T	P	
BR20008	Introduction to Electric and Hybrid Electric Vehicle	3	0	0	**3**

Course Objective

To provide a comprehensive understanding of EV configurations, propulsion systems, motor controls, battery management, power converters, and charging infrastructure, while integrating thermal safety, industrial standards, and emerging trends like V2X.

Prerequisites

Foundational knowledge in basic electrical and electronics engineering, electrical machines (induction motors), basic power electronic converters, and introductory engineering mechanics (force, torque, and power).

Course Outcomes:

CO-1: Compare the performance, dynamics, and architectures of conventional, hybrid, and electric vehicles.
CO-2: Select and evaluate electric motors and control strategies for vehicle propulsion systems.
CO-3: Analyze battery technologies, battery management systems, and alternative energy storage methods.
CO-4: Design and evaluate power converter topologies for wired, wireless, and renewable-integrated EV charging.
CO-5: Apply thermal safety, industrial charging standards, and emerging trends like V2X to EV ecosystem design.

CO-PO-PSO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO -1	-	3	-	2	-	-	-	-	1	-	2	1	2	-	2	-	-
CO -2	-	3	2	3	-	2	2	-	2	-	-	2	2	2	2	2	-
CO -3	-	3	2	3	-	2	0	-	2	-	2	2	2	2	3	-	-
CO -4	2	3	3	3	-	3	2	-	2	-	2	2	3	3	3	2	-
CO -5	2	2	0	2	1	2	3	3	3	2	3	3	1	1	3	3	3
avg	0.8	2.8	1.4	2.6	0.2	1.8	1.4	0.6	2	0.4	1.8	2	2	1.6	2.6	1.4	0.6

COURSE LAYOUT

Unit 1: EV Fundamentals, Vehicle Dynamics, and Powertrain Configurations

Overview, History, and Impact: Course Overview and History of Transportation and Vehicular Electrification, Vehicular Electrification Resurgence, Challenges, and Way Forward, Environmental, Social, and Economical Impact of Vehicular Electrification

Vehicle Dynamics: Vehicle Dynamics I & II, Overview of ICE and Characteristics

EV & HEV Configurations: CE Vehicle vs. Electric Vehicle Comparison, Hybrid EV Configuration and Operation (Parts I, II & III), Plug-in Hybrid Electric Vehicle (PHEV) and Operation, Fundamental of Hydrogen Fuel Cell Vehicle (FCV), Power Management and Comparison of Various EV Technologies

Unit 2: Propulsion Systems, Electrical Machines, and Motor Control

Propulsion System Fundamentals: Overview of Electric Propulsion System and its Components, Role of Power Electronics Converters in Electric Propulsion Systems, Electronic Control Unit (ECU) in EVs and HEVs

Electric Motors and Control Strategies: Induction Motor and Control for EVs, Permanent Magnet Synchronous Motor (PMSM) and Control for EVs, Brushless DC (BLDC) Motors and Control for EVs, Switched Reluctance Motor (SRM) and Control for EVs

Unit 3: Energy Storage, Charging Infrastructure, and Power Conversion

Energy Storage Systems: Battery Technologies for EVs, Battery Management System (BMS), Ultracapacitors and Flywheels, Fuel Cell Technologies

Charging Infrastructure & Power Converters: EV Charging Infrastructure in India & Architecture/Working of EV Charging, Types of EV Charging & Operation/Control of EV Charging Systems, AC-DC Converters with Power Factor Correction (PFC) for EV Charging, DC-DC Converters with Control for EV Charging, Renewable Energy Sources (RES) Integration and Control, Wireless EV Charging Systems

Unit 4: Thermal Management, Policies, Standards, and Future Trends

Thermal Management: Guidelines for Thermal Management of EVs, Thermal Management of Batteries, Thermal Management of Power Converters and Electric Motors,

Policies, Safety, and Standards:Policies and Economics for Grid Integration in EV Charging, Specification & Guidelines of Charging Standards in the EV Industry, Safety Standards in EVs and Recycling of Batteries

Emerging Trends: Business Models and Economics associated with Vehicular Electrification

Role of AI and the Concept of Vehicle-to-Everything (V2X) in the EV Sector

BOOKS AND REFERENCES

1. **C.C. Chan and K.T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press.**

2. **Ehsani, M., Gao, Y., Longo, S., and Ebrahimi, K., "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles," CRC Press, 2018.**
3. **Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals," Third Edition, CRC Press, 2021.**
4. **Kumar, Lalit, and Shailendra Jain, "Electric Propulsion System for Electric Vehicular Technology: A Review," *Renewable and Sustainable Energy Reviews* 29 (2014): 924-940.**
5. **F. R. Salmasi, "Control Strategies for Hybrid Electric Vehicles: Evolution, Classification, Comparison, and Future Trends," *IEEE Transactions on Vehicular Technology*, vol. 56, no. 5, pp. 2393–2404, Sep. 2007.**
6. **G. Pistoia, Ed., *Lithium-Ion Batteries: Advances and Applications*. London, England: Elsevier Science, 2018.**
7. **Warner, John T., *The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Components, Types, and Terminology*. Elsevier, 2024.**

https://www.niti.gov.in/sites/default/files/202108/HandbookforEVChargingInfrastructureImplementation081221.pdf https://e-amrit.niti.gov.in/reports-and-articles

(https://onlinecourses.swayam2.ac.in/nou26_ec04/preview)

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	EV charging and battery systems
8	Decent Work and Economic Growth	EV sector employability skills
9	Industry, Innovation and Infrastructure	Electric mobility innovation
11	Sustainable Cities and Communities	Cleaner urban transportation
13	Climate Action	Reduced vehicular carbon emissions

Course Code	Course Title	Credit Hours			Total
		L	T	P	
BN20010	Introduction to Python Programming	2	0	1	3

Course Objectives: To introduce Python programming fundamentals and develop basic problem-solving skills for engineering and renewable energy applications.

Course Outcomes (COs)

CO1: Familiarize students with Python programming environment and syntax.
CO2: Develop logical and problem-solving skills using Python
CO3: Implement basic to intermediate Python programs for real-world applications.
CO4: Introduce data handling, functions, and simple file operations.
CO5: Evaluate and fix the solution for problem arises during execution.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
CO2	-	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-
CO3	-	-	3	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO4	-	-	-	-	3	-	-	-	-	-	2	-	-	-	-	-	2
CO5	1	-	2	1	-	-	3	-	2	-	-	3	1	-	2	3	-
Avg.	0.8	0.6	1	0.2	1	-	1.2	-	0.4	-	0.4	0.6	0.2	0.6	0.4	1.2	0.6

Course Contents

Unit–I: Python Basics

Installation and configuration of Python (Anaconda / IDLE / VS Code).
Writing and executing first Python program.
Python keywords, identifiers, variables, and data types.
Input–Output operations and type conversion programs.

Unit–II: Control Structures

Programs using conditional statements (if, if–else, elif).
Programs using looping statements (for, while).
Use of break, continue, and pass.
Pattern printing using loops.

Unit–III: Data Structures

Programs using **Lists** (operations, slicing, methods).
Programs using **Tuples** and **Sets**.
Programs using **Dictionaries** (key-value operations).
Menu-driven programs using data structures.

Unit–IV: Functions and File Handling

User-defined functions and parameter passing.
Programs using recursion.
File handling operations (read, write, append).
Simple exception handling programs.

Software / Tools Required

Python 3.x
Anaconda / VS Code / PyCharm
Windows / Linux OS

Text Books

1. Reema Thareja, *Python Programming Using Problem Solving Approach*, Oxford University Press.
2. Guido van Rossum, *Python Tutorial*, Python Software Foundation.

Reference Books

1. E. Balagurusamy, *Problem Solving and Python Programming*, McGraw-Hill.
2. Mark Lutz, *Learning Python*, O'Reilly Media.
3. Online Resource: https://docs.python.org

SDG Mapping

SDG	Title	Contribution
4	Quality Education	Digital literacy and programming competency
8	Decent Work and Economic Growth	Industry-relevant software skills
9	Industry, Innovation and Infrastructure	Automation and engineering applications
10	Reduced Inequalities	Accessible technical skill development
13	Climate Action	Renewable energy data analysis and optimization

Ability Enhancement Course (AEC)	AE24002	Title	L	T	P	Total Credits
		Professional communication	2	0	0	2

Course Objectives: After completing this course, students will be able to:

- Understand the fundamental principles of the writing process and the conventions of academic and professional writing.
- Develop the ability to summarize and paraphrase texts accurately using their own words while maintaining the original meaning.
- Enhance critical thinking skills through the synthesis, analysis, interpretation, and evaluation of ideas and information.
- Learn to structure coherent and logical arguments with effective introductions, supporting points, and conclusions.
- Apply professional communication skills to produce clear, organized, ethical, and audience-appropriate written communication.

Course Outcomes:

CO1: Explain and apply the fundamental principles of the writing process and conventions of academic writing.

CO2:Summarize and paraphrase academic and professional texts accurately, clearly, and ethically in their own words.

CO3:Demonstrate critical thinking through the synthesis, analysis, interpretation, and evaluation of information and arguments.

CO4:Construct well-organized arguments with effective introductions, logical development of ideas, appropriate transitions, and meaningful conclusions.

CO5:Produce coherent, concise, grammatically appropriate, and audience-oriented written communication for academic and professional purposes.

Course Contents:

Unit I: Introduction to the Writing Process and Conventions of Academic Writing
Unit II: Writing in one's own words: Summarizing and Paraphrasing

Unit III: Critical Thinking: Syntheses, Analyses, and Evaluation

Unit IV: Structuring an Argument: Introduction, Interjection, and Conclusion

CO-PO-PSO Mapping of Paper

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	2	3	3	3	3	2	2	3	2	2	2	3	3	2	2	3	2
CO 2	2	3	3	3	3	3	2	3	2	2	3	3	3	2	3	3	2

CO 3	2	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3	3
CO 4	3	3	3	3	2	1	1	1	2	3	1	3	3	3	2	3	2
CO 5	3	2	2	2	2	1	1	1	2	3	2	3	3	3	3	3	3

Recommended Learning Resources

1. Liz Hamp-Lyons and Ben Heasley, *Study writing: A Course in Writing Skills for Academic Purposes* (Cambridge: CUP, 2006).
2. Renu Gupta, *A Course in Academic Writing* (New Delhi: Orient Black Swan, 2010).
3. Ilona Leki, *Academic Writing: Exploring Processes and Strategies* (New York: CUP, 2nd edn, 1998).
4. Gerald Graff and Cathy Birkenstein, *They Say/I Say: The Moves That Matter in Academic Writing* (New York: Norton, 2009).
5. Graff, Gerald, and Cathy Birkenstein. *They Say / I Say: The Moves That Matter in Academic Writing*. 4th Edition, W.W. Norton, 2018.
6. Cottrell, Stella. *The Study Skills Handbook*. 5th Edition, Macmillan, 2019.
7. Purdue Online Writing Lab (OWL). *Paraphrasing and Summarizing*. Purdue University, 2020.
8. Paul, Richard, and Linda Elder. *Critical Thinking: Tools for Taking Charge of Your Learning and Your Life*. 2nd Edition, Pearson, 2012.
9. Kirkman, Thomas W. *Academic Argument: Writing, Reading, and Thinking Critically*. Longman, 2013.

SDG Mapping for this Course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops advanced writing, analytical, and communication skills
SDG 5	Gender Equality	Encourages inclusive and equitable communication practices
SDG 8	Decent Work & Economic Growth	Enhances employability through professional communication skills
SDG 9	Industry, Innovation & Infrastructure	Promotes digital and organizational communication competence
SDG 16	Peace, Justice & Strong Institutions	Supports ethical communication, accountability, and transparency

SEMESTER 5

Course Code	Course Title	L	T	P	Total Credits
BR30001	Distributed Generation Systems	3	1	0	4

Prerequisite: Students should have prior knowledge of renewable energy technologies, electrical power systems, grid concepts, and basic electrical calculations. Understanding of solar PV systems, energy storage, and smart grid fundamentals is recommended.Course

Objectives:

To introduce the concepts, technologies, and applications of distributed generation systems with emphasis on renewable energy integration and small-scale power systems.

Course Outcomes (COs)

CO1: Explain the fundamentals and importance of distributed generation systems.
CO2: Identify various distributed energy resources and DG technologies.
CO3: Analyze integration, control, and protection issues in DG systems**.**
CO4: Apply DG concepts in rural electrification and smart grid applications.
CO5: Evaluate the economic, environmental, and technical impacts of distributed generation systems.

CO-PO-PSO Mapping

COs/POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2	-	-	-	-	3	-	-	-	-	2	2	-	-	-	3
CO2	3	3	2	-	2	-	2	-	-	-	-	-	3	2	-	-	-
CO3	3	3	3	2	3	-	-	-	-	-	2	-	3	3	-	-	-
CO4	-	3	3	-	2	2	3	-	-	2	1	-	-	3	2	1	3
CO5	-	3	-	2	-	2	3	2	-	-	2	3	-	-	3	2	3
Avg	1.8	2.8	1.6	0.8	1.4	0.8	2.2	0.4	-	0.4	1	1	1.6	1.6	1	0.6	1.8

Course Contents

Unit 1: Fundamentals of Distributed Generation (10 Hours)

Concept of centralized and distributed power generation, Definition, need, advantages, and limitations of distributed generation, Types of distributed generation systems, Overview of smart grid and microgrid concepts, Role of DG in renewable energy transition, Indian power sector scenario and DG policies.

Unit 2: Distributed Energy Resources and Technologies (10 Hours)

Solar PV–based distributed generation, Wind energy systems for distributed applications, Biomass and biogas-based DG systems, Small hydro and fuel cell systems, Introduction to energy storage systems and battery basics, Role of storage systems in DG applications.

Unit 3: Power Electronic Interfaces and DG Integration (10 Hours)

Basic concepts of power electronic interfaces and inverters, Grid-connected and islanded mode of operation, Basic control and protection issues in DG systems, Voltage regulation and power quality issues, Net metering and peer-to-peer energy trading concepts.

Unit 4: Applications and Case Studies of Distributed Generation (10 Hours)

Applications of DG in rural electrification, Smart city applications of DG systems, Economic and environmental benefits of DG, Challenges in DG implementation, Case studies of distributed generation projects in India.

Textbooks

1. **Ackermann, T., Distributed Generation, Wiley.**
2. **Gonen, T., Electric Power Distribution Engineering, CRC Press.**
3. **Masters, G.M., Renewable and Efficient Electric Power Systems, Wiley.**

Reference Materials

1. **MNRE reports on distributed renewable energy**
2. **CEA and IEEE standards (introductory level)**
3. **NPTEL lectures on Distributed Generation and Smart Grids**

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Distributed renewable energy generation and microgrids

8	Decent Work and Economic Growth	Skill development in DG technologies and smart grids
9	Industry, Innovation and Infrastructure	Smart grid and distributed energy innovations
11	Sustainable Cities and Communities	Reliable decentralized energy systems
13	Climate Action	Reduction in fossil fuel dependency through renewable DG

Course Code	Course Title	L	T	P	Total Credit
BR30003	Electric Vehicle Management System	3	0	2	4

Prerequisite: Students should possess basic understanding of electrical systems, batteries, motors, power electronics,

and renewable energy applications. Familiarity with electric circuits, charging systems, and vehicle fundamentals will be advantageous.

Course Objectives:
To provide students with basic knowledge of transformer principles, construction, operation, and applications in renewable energy systems.
Course Outcomes:
CO1: Explain the fundamentals, need, and environmental impact of electric vehicles.
CO2: Identify different types of electric vehicles and their operating principles.
CO3: Analyze the components and subsystems of battery electric vehicles.
CO4: Apply power electronic converters and battery management concepts in EV systems.
CO5: Evaluate EV technologies, safety systems, and drivetrain performance for sustainable transportation.

CO-PO-PSO Mapping

COs/POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2		-	-	1	3	-	-	1	-	2	2	-	3	-	2
CO2	3	3	2	-	1	-	2	-	-	-	-	1	3	2	2	-	-
CO3	3	3	3	2	3	-	1	-	-	-	2	-	3	3	2	-	-
CO4	3	2	3	2	3	1	2	-	-	1	2	-	3	3	2	1	2
CO5	2	3	2	2	2	3	3	2	1	2	2	3	2	2	3	2	1
Avg	2.8	2.6	2	1.6	1.8	1	2.2	0.4	0.2	0.8	1.2	1.2	2.6	2	2.4	0.6	1

Course Contents

Unit 1: Introduction to Electric Vehicles (10 Hours)
Need for electric vehicles, History and development of electric vehicles, Electric vehicles and environmental impact, Challenges in replacing internal combustion engine (ICE) vehicles, Major requirements and advantages of electric vehicles.
Unit 2: Types of Electric Vehicles and Their Applications (10 Hours)
Battery electric vehicles (BEVs), Hybrid electric vehicles (HEVs), Fuel cell electric vehicles (FCEVs), EVs using supply lines, EVs using flywheels and supercapacitors, Solar-powered vehicles, Linear motor–based vehicles, Advantages and limitations of different EV types.
Unit 3: Battery Electric Vehicle Components and Powertrain (10 Hours)
Battery parameters and characteristics, Electric motors and drives, Suspension system and driveshaft, Mechanical transmission system, Electronic control unit (ECU), Power electronic converters (DC–DC and DC–AC converters), Driving wheel mechanisms.
Unit 4: Battery Management and EV Safety Systems (10 Hours)
Battery management system (BMS), Battery safety and thermal management, On-board charger and auxiliary subsystem, Power steering unit, Common parts between ICE and EV drivetrain, Differences between ICE and EV drivetrain systems, EV safety and maintenance considerations.
Textbooks

1. **Electric and Hybrid Electric Vehicles: Fundamentals, Theory and Design — Iqbal Husain**
2. **Electric Vehicle Technology Explained — James Larminie and John Lowry**
3. **Electric and Hybrid Vehicles — Tom Denton**
4. **Electric Vehicles: Prospects and Challenges — Tariq Muneer**

Reference Books

1. **Modern Electric, Hybrid Electric, and Fuel Cell Vehicles — Mehrdad Ehsani**
2. **Electric Vehicle Engineering — Sandeep Dhameja**
3. **Hybrid Electric Vehicles: Principles and Applications — Chris Mi**
4. **Build Your Own Electric Vehicle — Seth Leitman and Bob Brant**
5. **Electric Vehicle Technology and Design — C. C. Chan**
6. **Advanced Electric Drive Vehicles — Ali Emadi**

SDG Mapping

SDG	Title	Contribution

7	Affordable and Clean Energy	Efficient electric mobility systems
8	Decent Work and Economic Growth	EV-related technical and industrial skills
9	Industry, Innovation and Infrastructure	Advanced EV technologies and charging infrastructure
11	Sustainable Cities and Communities	Cleaner urban transportation systems
13	Climate Action	Reduction of greenhouse gas emissions through EV adoption

Course Code	Course Title	L	T	P	Total Credit
BR30005	D.C. Machines and Transformer	3	1	0	4

Prerequisite

- Basic Electrical Engineering
- Fundamentals of Electrical Circuits and Electromagnetism
- Knowledge of AC and DC circuit concepts

Course Objectives:

To enable students to quantify the environmental impact of renewable energy systems by mastering the methodologies for calculating emission reductions, baseline data, and grid emission factors required for carbon credit certification.

Course Outcomes: After completing this course, students will be able to:

CO1: Explain the construction and operation of DC machines and transformers.
CO2: Analyze characteristics, losses, and efficiency of DC machines.
CO3: Apply starting, speed control, and testing methods for DC machines.
CO4: Analyze operation, regulation, and performance of single-phase transformers.
CO5: Evaluate testing methods and applications of transformers in power systems.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	-	-	-	1	-	1	2		-	-	1
CO2	3	3	2	1	2	-	-	-	-	-	1	-	3	2	-	-	-
CO3	3	3	3	2	3	-	-	-	1	1	2	-	3	3	-	1	1
CO4	3	3	2	2	2	-	1	-	-	-	1	-	2	2	1	-	-
CO5	2	3	2	3	2	1	1	1	-	1	2	2	2	3	2	1	2
Avg	2.8	2.8	1.8	1.6	1.8	0.2	0.4	0.2	0.2	0.6	1.2	0.6	2.4	2	0.6	0.4	0.8

Course Contents

Unit I-DC Generators: (12 Lectures)

Construction and principle of operation of DC machines – EMF equation for generator – Excitation techniques – characteristics of DC generators – applications of DC Generators, Back-emf and torque equations of DC motor – Armature reaction and commutation

Unit II-Testing of Generator (10 Lectures)

Starting, Speed Control and Testing of DC Machines, Characteristics of DC motors – losses and efficiency – applications of DC motors. Necessity of a starter – starting by 3-point and 4-point starters –speed control by armature voltage and field current control – testing of DC machines – brake test, Swinburne's test –Hopkinson's test–Field Test.

Unit III-Transformer: (10 Lectures)

Single-phase Transformers, Introduction to single-phase Transformers (Construction and principle of operation)–emf equation – operation on no-load and on load –lagging, leading and unity power factors loads –phasor diagrams– equivalent circuit – regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – all day efficiency.

Unit IV-Testing of Transformers and its applications: (8 Lectures)

Testing of Transformers, Open Circuit and Short Circuit tests – Sumpner's test – separation of losses Parallel operation with equal and unequal voltage ratios–auto transformer – equivalent circuit – comparison with two winding transformers.

Text Books

1. Dr.P. S Bimbhra, Electrical Machinery, 7/e, Khanna Publishers,2018.
2. I.J. Nagarath and D.P. Kothari, Electric Machines,4/e, McGraw Hill, 2010.

Reference Books

1. J.B. Gupta, Theory and performance of Electrical Machines, S.K.Kataria & Sons Publishers,2015.
2. A.E. Clayton and N N Hancock, Performance and Design of DC Machines, Oxford,1987.
3. Abhijit Chakrabarti and Sudipta Debnath, Electrical Machines, 1/e, Mc Graw Hill,2015.
4. J. Chapman, Electric Machine Fundamentals, 5/e, McGraw Hill, 2011.

e- Resources https://nptel.ac.in/courses/108/105/108105155/

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Efficient electrical machines and transformer systems
8	Decent Work and Economic Growth	Technical competency in electrical machinery
9	Industry, Innovation and Infrastructure	Power system equipment and industrial applications
11	Sustainable Cities and Communities	Reliable electrical infrastructure support
12	Responsible Consumption and Production	Energy-efficient machine operation and reduced losses

Course Code	Course Title	L	T	P	Total Credit
BR30007	Hydrogen Energy and Fuel Cell	3	1	0	4

Prerequisite

Basic knowledge of renewable energy systems
Fundamentals of chemistry and electrical engineering
Basic understanding of energy conversion systems

Course Objectives:

To introduce the fundamentals of hydrogen energy and fuel cell technologies, including their production, storage, working principles, and applications in sustainable and renewable energy systems.

Course Outcomes (COs): After completing this course, students will be able to:

CO1: Explain the fundamentals and importance of hydrogen energy systems.
CO2: Describe hydrogen production, storage, and safety methods.
CO3: Analyze the working principles and performance of fuel cells.
CO4: Apply hydrogen and fuel cell technologies in energy applications.
CO5: Evaluate the role of hydrogen energy in sustainable and clean energy development.

CO-PO-PSO Mapping

COs/POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2	-	-	-	-	3	-	-	-	-	2	2	-	2	-	-
CO2	3	3	2	-	2	2	-	-	-	-	-	-	3	2	-	-	1
CO3	3	3	3	2	3	-	-	-	-	-	-	-	3	3	2	-	3
CO4	-	3	3	-	2	-	2	-	-	2	-	-	-	3	2	1	2
CO5	-	-	-	2	-	2	3	2	-	-	-	3	-	-	3	2	-
Avg	1.8	2.2	1.6	0.8	1.4	0.8	1.6	0.4	-	0.4	-	1	1.6	1.6	1.8	0.6	1.2

Course Contents

Unit 1: Introduction to Hydrogen Energy (10 Hours)

Energy scenario and need for hydrogen energy, Hydrogen as an energy carrier, Physical and chemical properties of hydrogen, Hydrogen energy cycle, Advantages and challenges of hydrogen energy, Comparison of hydrogen with conventional fuels, Role of hydrogen in clean and renewable energy systems.

Unit 2: Hydrogen Production, Storage and Safety (10 Hours)

Methods of hydrogen production, Steam methane reforming, Electrolysis of water, Renewable-based hydrogen (green hydrogen), Hydrogen storage methods, Compressed hydrogen, Liquid hydrogen, Metal hydrides, Hydrogen transportation, Safety aspects and handling of hydrogen, Standards and codes.

Unit 3: Fuel Cells and Their Types (10 Hours)

Basic principle of fuel cells, Components of a fuel cell system, Types of fuel cells, PEMFC, SOFC, AFC, Efficiency and performance of fuel cells, Characteristics and comparison of fuel cells.

Unit 4: Applications of Hydrogen Energy and Fuel Cells (10 Hours)

Applications of fuel cells in power generation, Electric vehicles, Backup power systems, Hydrogen economy concept, Environmental impacts of hydrogen energy systems, Recent developments and future scope of hydrogen technologies.

Textbooks:

1. **Larminie, J. & Dicks, A. – Fuel Cell Systems Explained, Wiley**
2. **Bent Sørensen – Hydrogen and Fuel Cells, Elsevier**

Reference Books

1. **NPTEL Lecture Notes – Hydrogen Energy & Fuel Cells (IIT)**
2. **MNRE Reports on Green Hydrogen Mission**

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Hydrogen and fuel-cell energy technologies
8	Decent Work and Economic Growth	Emerging skills in hydrogen economy and clean energy
9	Industry, Innovation and Infrastructure	Innovation in fuel cells and hydrogen systems
11	Sustainable Cities and Communities	Clean transportation and backup energy applications
13	Climate Action	Promotion of zero-emission energy technologies

	Subject Code	Title	T	L	P	Total Credits
Skill Enhancement Course						

(SEC)	BR35001	Mechatronics and Robotics	3	1	0	4

Course Objectives

Fundamentals: Understand key components and characteristics of mechatronics systems.
Circuits: Grasp active and passive electrical circuit principles.
Trends: Explore recent advancements and modern applications in mechatronics.
Design: Master techniques for analyzing and designing mechatronic processes.
Evaluation: Assess and select optimal design solutions for engineering challenges.

Course Outcomes:-

Students will be able to:-
CO1: Understand characteristics and the components of mechatronics systems.
CO2: Discuss recent trends in Mechatronics.
CO3: Describe active & Passive electrical circuits.
CO4: Analyze the techniques used to design a mechatronics process.
CO5: Evaluate the possible design solutions.

CO-PO-PSO Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	–	3	2	1	–	–	2	–	–	–	–	1	1	1	–	2	–
CO2	–	2	–	–	–	–	2	2	2	–	–	3	–	–	–	2	2
CO3	–	3	2	1	–	–	–	–	–	–	–	–	2	1	–	–	–
CO4	–	2	2	3	–	3	2	–	1	–	–	1	–	3	2	2	–
CO5	1	2	–	3	–	3	–	2	1	–	2	1	–	3	3	1	2
Average Score	1	2.4	2	2.3	–	3	2	2	1.3	–	2	1.5	1.5	2	2.5	1.8	2

Course Contents

UNIT-I Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. [10]

UNIT-II Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by Camshafts, electronic cams, indexing Mechanisms, tool magazines, transfer systems. [10]

UNIT-III Probability, Random variables, Probability distribution and density functions, Joint density and conditional distribution, Functions of random variables and random vectors. [12]

UNIT-IV Introduction to robotics: brief history, types, classification and usage and the science and technology of robots. [8]

UNIT-V Kinematics of robot: direct and inverse kinematics problems and workspace, inverse kinematics solution for the general 6R manipulator, redundant and over-constrained manipulators.Velocity and static analysis of manipulators: Linear and angular velocity, Jacobian of manipulators, singularity, static analysis. [10]

Text Books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. S. K. Saha, “Introduction to Robotics”, Tata McGraw-Hill Publishing Company Ltd. (2008).

Reference Books:

1. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
2. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005.
3. Musa Jouaneh, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.
4. M. P. Groover, M. Weiss, R. N. Nagel and N. G. Odrey, "Industrial Robotics-Technology, Programming and Applications", McGrawHill Book and Company (1986).
5. Pires, "Industrial Robot Programming–Building Application for the Factories of the Future", Springer (2007).

SDG Mapping

SDG	Title	Contribution
4	Quality Education	Foundational technical knowledge in mechatronics, circuit analysis, and engineering design methodology
7	Affordable and Clean Energy	Energy-efficient circuit design and optimized control of electromechanical systems
8	Decent Work and Economic Growth	Technical skill development for careers in automation, modern industry trends, and smart manufacturing
9	Industry, Innovation and Infrastructure	Innovation in mechatronic system integration, process automation, and smart sensor technologies
11	Sustainable Cities and Communities	Mechatronic applications in smart infrastructure, automated transit, and urban efficiency
12	Responsible Consumption and Production	Optimized process design and circuit evaluation to minimize material and energy waste
13	Climate Action	Sustainable design selection and low-emission engineering solutions for smart devices

SEMESTER 6

Course Code	Course Title	L	T	P	Total Credit
BR30002	Introduction to Power system	3	1	0	4

Prerequisite
Basic knowledge of electricity, electrical circuits, voltage, current, and renewable energy concepts.
Course Objectives:
To provide fundamental understanding of the structure, components, and operation of electric power systems including generation, transmission, and distribution.
The course also aims to relate power system concepts to renewable energy integration, safety, and basic grid practices.
Course Outcomes (COs): After completing this course, the student will be able to:
CO1: Explain the fundamentals and structure of electric power systems.
CO2: Describe conventional and renewable power generation systems.
CO3: Analyze transmission, distribution, and smart grid concepts.
CO4: Identify power system components, protection devices, and safety practices.
CO5: Evaluate grid integration and sustainable development aspects of power systems.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	2	-	-	-	-	1	2	-	-	-	-
CO2	3	2	2	-	-	-	3	-	-	-	-	-	3	-	2	-	-
CO3	3	3	3	-	2	-	-	-	-	-	1	-	3	2	-	-	2
CO4	-	2	-	-	2	3	-	2	1	-	-	-	-	3	2	-	2
CO5	-	-	2	-	-	2	3	-	-	-	2	3	-	-	3	2	-
Avg	1.8	1.8	1.4	-	0.8	1	1.6	0.4	0.2	-	0.6	0.8	1.6	1	1.4	0.4	0.8

Course Contents

Unit 1: Fundamentals of Electric Power System (10 Hours)
Overview of electric power system, Structure of power system: generation, transmission, and distribution, Types of power plants: thermal, hydro, nuclear, solar, wind, and biomass, AC vs DC power system, Single-line diagram of a simple power system, Introduction to Indian power sector.
Unit 2: Power Generation Systems and Renewable Energy (10 Hours)
Basics of power generation from renewable sources, Conventional vs renewable power generation, Solar, wind, hydro, biomass-based generation systems, Energy demand and generation scenario, Role of renewable energy in modern power systems.
Unit 3: Transmission, Distribution, and Smart Grid Systems (10 Hours)
Introduction to transmission systems, Types of transmission lines, Basics of primary and secondary distribution systems, Substations: types and components, Introduction to smart grid and microgrids, Grid modernization concepts.
Unit 4: Power System Components, Protection, and Safety (10 Hours)
Power system components: generators, transformers, transmission lines, Basics of switchgear and protection, Circuit breakers and relays, Introduction to power system faults, Electrical safety practices, Grid integration of renewable energy systems, Sustainable development aspects.

Textbooks & References
C.L. Wadhwa – Electrical Power Systems
Hadi Saadat – Power System Analysis (Introductory chapters)
NPTEL Lectures on Power Systems (IIT Kharagpur / IIT Bombay)
P.S. Bimbhra – Power System Protection

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Understanding power generation, transmission, and renewable integration
8	Decent Work and Economic Growth	Skill development for power and energy industries
9	Industry, Innovation and Infrastructure	Smart grids, substations, and modern electrical infrastructure
11	Sustainable Cities and Communities	Reliable and sustainable power distribution systems
13	Climate Action	Renewable energy integration and sustainable grid practices

Course Code	Course Title	L	T	P	Total Credit
BR30004	Introduction to Control System	3	0	1	4

Prerequisite
Basic Electrical Engineering, Fundamentals of Electronics, and Engineering Mathematics.
Course Objectives:
To introduce the fundamental concepts, components, and mathematical modeling of control systems. To enable students to analyze and understand the behavior and stability of basic control systems used in engineering and renewable energy applications.
Course Outcomes (COs): After completing this course, students will be able to

CO1: Explain the fundamentals and classifications of control systems.
CO2: Illustrate mathematical models and transfer functions of simple systems.
CO3: Analyze time response and stability characteristics of control systems.
CO4: Apply P, PI, and PID controllers in engineering applications.
CO5: Evaluate control system applications in renewable energy systems.

CO-PO-PSO Mapping

COs/POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	-	-	-	-	1	-	-	-	-	1	2	-	-	-	-
CO2	3	3	2	-	2	-	-	-	-	-	-	-	3	2	-	-	2
CO3	3	3	-	2	2	-	-	-	-	-	1	-	-	3	-	-	2
CO4	-	3	3	-	3	-	-	-	-	1	-	-	2	3	-	-	3
CO5	-	-	2	-	3	2	3	-	-	-	-	2	-	-	3	2	3
Avg	1.8	2.2	1.4	0.4	2	0.4	0.8			0.2	0.2	0.6	1.4	1.6	0.6	0.4	2

Course Contents

Unit 1: Fundamentals of Control Systems (10 Hours)
Introduction to control systems, Need for control systems in engineering and renewable energy, Classification of control systems, Open-loop and closed-loop systems, Block diagram representation, Feedback concept and importance, Applications in solar tracker control, battery charge controller, and wind turbine speed control.
Unit 2: Mathematical Modeling and System Representation (10 Hours)
Mathematical models of simple systems, Electrical systems (R, L, C basics), Mechanical systems (mass-spring-damper concept), Transfer function and physical meaning, Block diagram reduction techniques, Introduction to signal flow graphs.
Unit 3: Time Response and Stability Analysis (10 Hours)
Time response of control systems, Step response analysis, Rise time, peak time, settling time, Stability concepts, Stable, unstable, and marginally stable systems, Introduction to P, PI, and PID controllers.
Unit 4: Renewable Energy Control Applications (10 Hours)
Control of inverters and converters, MPPT control overview, Battery management and charge control systems, Microgrid and energy management systems, Applications of control systems in renewable energy integration.
Textbooks

1. **I.J. Nagrath & M. Gopal, Control Systems Engineering, New Age International**
2. **Norman S. Nise, Control Systems Engineering, Wiley**
3. **K. Ogata, Modern Control Engineering, Prentice Hall (selected sections only)**

Reference Books

1. **B.C. Kuo, Automatic Control Systems**
2. **Raghuwanshi & Kumar, Control Systems**

Practical:

1. Pole-zero plot
2. First order unity feedback
3. Second order unity feedback system
4. Type zero-one-Two System
5. Study the effect of addition of zeros to the forward path transfer function of a closed loop system
6. Study the effect of addition of poles to the forward path transfer function of a control system
7. To obtain root locus for a given transfer function of the system
8. To study the effect of PI, PD and PID controller on a control system

link:- https://ce-dei.vlabs.ac.in/Objective.html

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Control applications in renewable energy systems
8	Decent Work and Economic Growth	Automation and industrial control skills
9	Industry, Innovation and Infrastructure	Smart control technologies and system automation
11	Sustainable Cities and Communities	Intelligent energy management systems
13	Climate Action	Efficient renewable energy control and reduced energy wastage

Course Code	Course Title	L	T	P	Total Credit
BR30006	Microprocessor and Microcontroller with Interfacing: Industry Collaboration	2	1	0	3

Prerequisite

Basic Electrical Engineering, Digital Electronics, Fundamentals of Computers, and Basic Programming Concepts.

Course Objectives:

To provide fundamental knowledge of microprocessors and microcontrollers with emphasis on interfacing techniques for real-time industrial applications. To develop hands-on skills in programming, peripheral interfacing, and troubleshooting relevant to automation and embedded systems used in industry.

Course Outcomes (COs): After completion of this course, students will be able to:

CO1: Explain the fundamentals of microprocessors and microcontrollers.
CO2: Apply programming concepts for microcontroller-based systems.
CO3: Analyze interfacing techniques using sensors and peripheral devices.
CO4: Develop microcontroller applications for renewable energy systems.
CO5: Evaluate automation and monitoring systems used in smart energy applications.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-	-	3
CO2	3	-	2	-	3	-	-	-	-	1	-	-	3	2	-	-	-
CO3	-	3	2	2	3	-	-	-	-	-	-	-	-	3	-	-	2
CO4	-	-	3	-	3	1	2	-	-	-	-	-	3	3	2	-	1
CO5	-	-	-	2	3	-	3	-	-	-	2	2	-	-	3	2	-
Avg	1.2	1	1.4	0.8	2.4	0.2	1	-	-	0.2	0.4	0.6	1.6	1.6	1	0.4	1.2

Course Contents

Unit 1: Fundamentals of Microprocessors (10 Hours)

Introduction to Microprocessors and Microcontrollers, Difference between Microprocessor and Microcontroller, 8086 Architecture (ALU, Registers, Bus structure), Instruction Set basics and Addressing Modes, Introduction to Assembly Language Programming, Applications in power systems and renewable energy systems, Basic control logic used in inverters and monitoring units.

Unit 2: Microcontroller Architecture and Programming (10 Hours)

Introduction to 8051/ATmega/PIC Microcontrollers, Internal Architecture and Pin Diagram, Memory Organization, I/O Ports and Timers, Interrupts and Serial Communication, Embedded C Programming basics, Simple programs: LED control, delay, counter, relay switching, Applications in solar charge controllers and wind controllers.

Unit 3: Interfacing Techniques and Data Acquisition (10 Hours)

Interfacing of sensors (Voltage, Current, Temperature, LDR), ADC and DAC, LCD and Keypad interfacing, Relays and Motor interfacing, Microcontroller-based data acquisition systems, Introduction to IoT-enabled energy monitoring systems.

Unit 4: Renewable Energy Applications and Case Studies (10 Hours)

Microcontroller applications in Solar PV monitoring systems, Battery Management Systems (BMS), Smart Energy Metering Systems, Renewable energy automation and control systems, Case studies and industrial applications.

Text Books

1. **Ramesh Gaonkar – Microprocessor Architecture, Programming and Applications**
2. **Mazidi & Mazidi – The 8051 Microcontroller and Embedded Systems**

3. **Raj Kamal – Embedded Systems**

Reference / Industry Learning Resources

1. **NPTEL: Microprocessors and Microcontrollers**
2. **Arduino & ATmega Datasheets**
3. **Industry manuals (Solar charge controllers, inverters)**

SDG Mapping

SDG	Title	Contribution
4	Quality Education	Embedded programming and automation learning
7	Affordable and Clean Energy	Smart renewable energy monitoring systems
8	Decent Work and Economic Growth	Industrial automation and technical employability
9	Industry, Innovation and Infrastructure	Microcontroller-based industrial applications
13	Climate Action	Smart energy monitoring and efficient energy management

Course Code	Course Title	L	T	P	Total Credit
BR30008	IoT-Based Real-Time Solar PV Monitoring System	3	1	0	4

Course Objectives :

To introduce the fundamentals of IoT architecture, devices, and communication technologies, and to enable students to design and implement basic IoT-based monitoring and control applications for real-world and energy-related systems.

Course Outcomes (COs): After completing this course, the student will be able to:

CO1: Understand basic concepts of IoT and smart systems.
CO2: Identify IoT components used in energy systems.
CO3: Explain data monitoring and control using IoT.
CO4: Apply IoT concepts in renewable energy applications.
CO5: Develop the programme for different project using IOT

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	-	-	-	3	-	-	-	-	-	-	-	1	-	-	-	-
CO2	-	-	3	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	3	-	-	-	-	-	-	-	-	1	-	-	-	-	3	-
CO4	-	-	-	-	-	-	2	-	-	-	-	2	-	-	-	2	2
CO5	2	-	3	-	3	-	1	-	-	3	-	-	-	-	3	-	1
Avg	0.4	0.6	1.2	-	1.8	-	0.5	-	-	-	-	0.4	0.25	-	0.75	1.25	0.5

Course Contents

Unit I: IoT Fundamentals

1. Introduction to IoT and smart devices
2. Sensors, actuators, and controllers
3. Basic networking concepts
4. IoT architecture and working principle

Unit II: IoT Platforms and Communication Microcontrollers (Arduino, Raspberry Pi – overview)

1. Communication protocols (MQTT, HTTP – basics)
2. Cloud platforms and data storage
3. Cybersecurity basics in IoT

Unit III: IoT Applications in Renewable Energy

1. IoT in solar power monitoring
2. Smart meters and energy management
3. Predictive maintenance using IoT
4. Case studies of IoT-based energy systems

Unit IV: Design & Implementation of an IoT-Based Real-Time Solar PV Monitoring System

1. System Architecture & Hardware Setup: Block diagram, selection of components, and sensor interfacing (voltage, current, temperature, and solar irradiance).
2. FiLocal data processing: Calculating instantaneous voltage (V), current (I), power (P = V xI), and energy yield (kWh).
3. Cloud Dashboard Setup: Sending live data to cloud platforms (ThingsBoard/Blynk/Grafana) for real-time visualization.
4. Fault Detection & Alerts: Setting up threshold alerts for low generation, shading, or overheating.
5. Testing & Field Validation: Calibrating sensors and testing the monitoring system on a real solar panel setup.

Textbooks

1. "Internet of Things: A Hands-On Approach" – Arshdeep Bahga & Vijay Madisetti
2. "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things" – David Hanes et al.

Reference Books

3. “Building the Internet of Things” – Maciej Kranz
4. “IoT and Edge Computing for Architects” – Timothy Chou
5. “Getting Started with the Internet of Things” – Cuno Pfister

SDG Mapping

SDG	Title	Contribution
4	Quality Education	Digital and IoT literacy development
7	Affordable and Clean Energy	IoT-based renewable energy monitoring
9	Industry, Innovation and Infrastructure	Smart devices, automation, and digital infrastructure
11	Sustainable Cities and Communities	Smart energy and monitoring systems
13	Climate Action	Energy-efficient monitoring and predictive maintenance

Course Code	Subject Name	L	T	P	Total
BR30010	Electrical CAD Software	1	0	1	2

Course Objectives

To understand the fundamentals of electrical CAD tools
To develop skills in schematic design and drafting
To perform circuit simulation and analysis
To design electrical systems using modern software

Course Outcomes (COs)

CO1: Explain the basics of electrical CAD software and tools
CO2: Develop electrical schematics using CAD tools
CO3: Analyze electrical circuits using simulation software
CO4: Evaluate the problem arise in CAD tools.
CO5: Design electrical layouts for practical applications

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO3	-	3	-	-	2	-	1	-	1	1	-	-	-	3	2	-	1
CO4	-	-	-	3	-	-	-	3	1	-	2	-	2	1	-	3	2
CO5	-	3	-	-	-	-	2	2	-	2	-	-	-	-	-	-	-
Avg	0.6	1.4	-	0.6	0.4	-	0.6	1	0.4	0.8	0.5		0.6	1.4	0.4	0.6	0.8

Course Contents

Unit 1: Introduction to Electrical CAD Software (6 Hour)

Introduction to CAD in electrical engineering, Overview of tools: AutoCAD Electrical & MATLAB Simulink, User interface, commands, and navigation, Drawing setup, templates, and file handling

Unit 2: Electrical Schematic Design & Drafting (6 Hours)

Electrical symbols and standards (IEC/IEEE), Circuit diagram creation (AC/DC circuits), Wiring, labeling, and annotations, Component libraries and BOM generation, Introduction to panel wiring diagrams

Unit 3: Circuit Simulation and Analysis (9 Hours)

Basics of circuit simulation, Simulation using: MATLAB Simulink, Voltage, current, and power analysis, Transient and steady-state analysis, Fault detection and troubleshooting

Unit 4: Electrical Layout Design & Applications (9 Hours)

Single-line diagrams (SLD), Electrical panel and wiring layout design, Cable routing and load distribution, Power system basics using ETAP , Basic solar PV system layout design,

Practical / Lab Work

Introduction to AutoCAD Electrical interface, Drawing electrical circuits and symbols
Residential wiring layout design
Transient analysis using MATLAB Simulink
Single-line diagram creation

Text Books

1. **AutoCAD Electrical 2023 for Electrical Control Designers** – *Prof. Sham Tickoo, CADCIM Technologies*
2. **AutoCAD Electrical 2025: A Tutorial Approach** – *Prof. Sham Tickoo, CADCIM Technologies* \

Reference Books

1. **AutoCAD Electrical 2022 for Electrical Control Designers** – *Prof. Sham Tickoo, CADCIM Technologies*
2. **Circuit Simulation with SPICE** – *Paul W. Tuinenga*

3. **Power System Analysis** – *Hadi Saadat*
4. **MATLAB for Engineers** – *Holly Moore*

SDG Mapping

SDG	Title	Contribution
4	Quality Education	CAD and simulation skill development
7	Affordable and Clean Energy	Design of efficient electrical and solar PV systems
8	Decent Work and Economic Growth	Industry-ready software and drafting skills
9	Industry, Innovation and Infrastructure	Electrical CAD, simulation, and infrastructure design
13	Climate Action	Sustainable electrical system planning and optimization

Course Category	Course Code	Course Title	Credits			Total Credits
			L	T	P	
Skill Enhancement Course	BV35002	Research Design and Scientific Writing	3	0	1	4

Course Objectives:

1. To understand the fundamentals of research and research design.
2. To develop skills in collecting, analyzing, and interpreting research data.
3. To learn academic and scientific writing standards.
4. To prepare students to write research proposals, reports, and publishable manuscripts.

By the end of this course, students will be able to:

Course Outcome

CO1:Explain the fundamental concepts, principles, research ethics, and scientific methods used in research design and academic writing.

CO2:Interpret research problems, review relevant literature, formulate research objectives, hypotheses, and select appropriate research designs.

CO3:Apply suitable research methodologies, sampling techniques, data collection methods, and citation styles to conduct systematic research.

CO4:Analyze quantitative and qualitative data using appropriate analytical tools and interpret research findings to address research objectives.

CO5:Evaluate the quality, validity, reliability, ethical standards, and scholarly contributions of research studies and scientific publications.

CO6:Develop research proposals, scientific reports, and publishable research manuscripts by integrating research findings with accepted academic writing and referencing standards.

CO-PO-PSO Mapping for Fundamentals of Entrepreneurship

*(Rate correlations: **1** - Weakly Mapped, **2** - Moderately Mapped, **3** - Strongly Mapped, **"_"** - No Correlation).*

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	1	1	1	–	1	1	1	1	1	–	3	1	–	1	1
CO2	1	3	2	2	2	1	1	1	2	1	2	1	3	2	1	2	2
CO3	1	2	1	3	3	2	1	1	1	1	2	1	3	3	1	2	2
CO4	2	2	2	3	2	1	1	1	1	2	2	1	2	2	3	2	2
CO5	2	2	2	3	3	2	1	1	2	2	3	1	3	3	2	2	3
CO6	2	2	2	2	3	2	1	2	2	2	1	2	1	1	3	3	3
AVG	1.5	2.3	1.7	2.3	2.3	1.6	1.0	1.2	1.5	1.5	1.8	1.2	2.5	2.0	2.0	2.0	2.2

Unit I: Foundations of Research and Research Design

a) Meaning, nature, scope, and importance of research

b) Types of research: Basic, Applied, Action, Exploratory, Descriptive, Explanatory, Experimental

c) Research process and scientific method

d) Research problem identification

e) Literature review and research gap identification

f) Research objectives and research questions

g) Hypothesis: Meaning, formulation, and testing

h) Variables and conceptual framework

i) Research ethics and responsible conduct of research

Unit II: Research Design and Data Collection

a) Meaning and components of research design

b) Quantitative, Qualitative, and Mixed-method research

c) Sampling: Population, sampling frame, sample size

d) Probability and non-probability sampling techniques

e) Sources of data: Primary and Secondary

f) Data collection methods

- Questionnaire
- Interview
- Observation
- Focus Group Discussion (FGD)

- Case Study

g) Questionnaire design and pilot testing

h) Reliability and validity

Unit III: Data Analysis and Interpretation

a) Data preparation and coding

b) Data cleaning and tabulation

c) Descriptive statistics

- Mean
- Median
- Mode
- Standard deviation

d) Introduction to inferential statistics

e) Correlation and Regression (basic concepts)

f) Introduction to software

- MS Excel
- SPSS
- R

g) Data visualization

h) Interpretation of results

i) Drawing conclusions and managerial implications

Unit IV: Scientific Writing and Research Publication

a) Principles of academic and scientific writing

b) Structure of a research paper

- Title
- Abstract
- Keywords
- Introduction
- Literature Review
- Methodology
- Results
- Discussion
- Conclusion
- References

c) Citation styles (APA 7th, IEEE, Chicago)

d) Reference management tools (Mendeley, Zotero)

e) Avoiding plagiarism

f) AI-assisted academic writing: opportunities and ethical use

g) Selecting journals and conferences

h) Peer review and publication process

i) Writing research proposals and project reports

Practical

1. Identifying a research problem
2. Preparing a problem statement

3. Developing research objectives and hypotheses
4. Designing a questionnaire using Google Forms
5. Selecting an appropriate sampling technique
6. Preparing a data collection plan
7. Data entry in Excel/SPSS
8. Creating tables and charts
9. Basic statistical analysis
10. Interpretation of findings
11. Writing an abstract
12. Preparing a literature review
13. Managing references using Mendeley/Zotero
14. Plagiarism checking
15. Preparing a mini research paper

Suggested Textbooks

Text Books

1. **Kothari, C. R., & Garg, G. (2019).** *Research Methodology: Methods and Techniques* (4th ed.). New Age International Publishers.
2. **Kumar, R. (2024).** Research methodology: A step-by-step guide for beginners (6th ed.) SAGE Publications.

Reference Book

1. Thomas, C. G. (2021). ***Research methodology and scientific writing*** **(2nd ed.). Springer.** https://doi.org/10.1007/978-3-030-64865-7
2. Gastel, B., & Day, R. A. (2024). ***How to write and publish a scientific paper*** **(9th ed.). Cambridge University Press.**
3. **Sekaran, U., & Bougie, R. (2020).** *Research Methods for Business: A Skill Building Approach* (8th ed.). John Wiley & Sons.
4. **Creswell, J. W., & Creswell, J. D. (2023).** *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (7th ed.). Sage Publications.
5. **Kerlinger, F. N., & Lee, H. B. (2000).** *Foundations of behavioral research (4th ed.). Wadsworth Publishing.*

SDG No.	SDG Title	**Nature of Contribution to this Subject**
SDG 4	Quality Education	Develops research skills, critical thinking, scientific writing, lifelong learning, and evidence-based knowledge creation to improve academic quality and professional competence.
SDG 8	Decent Work and Economic Growth	Equips students with research competencies to identify entrepreneurial opportunities, solve business problems, and support innovation-driven economic growth.

SDG 9	Industry, Innovation and Infrastructure	Promotes innovation through systematic research, problem-solving, technology adoption, and evidence-based decision-making for sustainable industrial development.
SDG 10	Reduced Inequalities	Supports inclusive research by addressing issues of marginalized and tribal communities, ensuring equitable participation and policy recommendations.
SDG 16	Peace, Justice and Strong Institutions	Emphasizes research ethics, academic integrity, transparency, plagiarism prevention, and responsible conduct of research, strengthening trustworthy institutions.
SDG 17	Partnerships for the Goals	Encourages collaborative research, interdisciplinary studies, academic networking, and knowledge sharing among institutions, industries, and communities to achieve sustainable development goals.

SEMESTER 7

Course Code	Course Title	L	T	P	Total Credit
IP40081	Industrial Internship (Solar/wind/Electrical Vehicle/AutoCAD. Etc.)	0	0	20	20

Course Learning Objectives:

To enable students to acquire practical knowledge and to act professionally in this area. This is meant to provide a scope to the students to apply theoretical knowledge in the real world, explore further in-depth knowledge in Renewable Energy Sources.

Course Learning Outcomes:

CO1-The students will have working knowledge in the real world and operate.

CO2- Develop an understanding of the importance and scope of industry interface .

CO3- Understand the changing micro and macro environment of organizations and importance of industry research and forecasting.

CO4- Develop an understanding of the competitive strategies for industry.

CO5- Establish a link between academic programme and industry as a strategic tool for staying ahead in a competitive

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	**1**	**2**	**3**	**2**	**1**	**1**	**2**	**1**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**3**
CO2	**1**	**2**	**1**	**2**	**-**	**1**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**3**
CO3	**2**	**2**	**1**	**3**	**1**	**1**	**2**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**2**
CO4	**2**	**2**	**1**	**3**	**-**	**1**	**1**	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**1**	**3**
CO5	**1**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**3**
Average	**1.4**	**2**	**1.6**	**2.4**	**0.6**	**1.2**	**1.6**	**2.4**	**2.6**	**1.6**	**1.8**	**2.4**	**1.8**	**1.6**	**1.8**	**1.4**	**2.8**

PROCESS / GUIDELINES:

1) The student will be required to undergo a field placement for a total duration of 6 months in their chosen area of interest Or institute will depute the students to various organizations looking at their area of interest.

2) In case the student makes the choice of the organization, it has to be made in consultation with the Institute. The Institute for this purpose should assign an internal faculty member who will act as the mentor throughout the Project. The assignment of mentor and choice of project should be made.

3) The study conducted by the student will be a full-time effort.

4) The proposal for the Summer Project or title of the project should be submitted to the Institute, which will ensure the registration of students for Project.

Students should prepare these proposals in consultation with the Internal and External Guide.

5) Students should send Joining Report on the first day of the joining which should be duly signed by the external guide.

6) Student should also send weekly reports every week keeping posted about the work –in – progress regarding project to the institute.

7) The format for the proposal or deciding about project title is as given below:

1. Title of the study
2. Need for the study (Stress on Need for study-current trends in the area)
3. A review of earlier research studies conducted
4. Objectives of the study
5. Methodology
6. Proposed outcomes and benefits of the study

8) The project should complete in time. Late submissions should not be entertained. A soft copy of all reports is to be submitted to Department on or before the submission date.

9) There shall be 2 copies of project reports along with soft copy to be submitted by each student to the School.

10) There will be a project viva-voice conducted by the University.

Deliverables:

The students are required to deliver the following Deliverables.

1) Joining Report and deciding project title/ proposal

2) Submission of project report (Soft copy + Hard copy- 2no.s /Project)

3) Presentation (for organization and the Institute)

4) Presentation for Viva-voce examination to be conducted by the University.

5) Student to present 1(One) copy to the organization and get the Certificate.

Format for Project Reports

The format for the Major Concurrent Project reports should be in the following manner.

1. Executive Summary
2. About the organization – Brief
3. Certificate of Completion
4. Introduction of the study
5. Objectives
6. Analysis and Findings
7. Discussion
8. Conclusion
9. References

In certain cases, students may change the format in consultation with his mentor and the External Guide. Enough care should be taken that the Project report focuses the study undertaken by the student and its findings. The report should contain minimum 25 pages with the following styles:

i) A-4 size paper (Executive Bond)

ii) MS Word style with Times New Roman Font

iii) Font size -12 for Text and 14 for headings

iv) Paper settings with 1-inch margins on all the four sides.

SDG No.	SDG Title	Justification
SDG 4	Quality Education	Enhances experiential learning and bridges academic concepts with industry-relevant skills.
SDG 7	Affordable and Clean Energy	Drives the practical operation, efficiency, and adoption of renewable energy systems.
SDG 8	Decent Work and Economic Growth	Fosters job readiness, entrepreneurship, and sustainable career paths in the energy industry.
SDG 9	Industry, Innovation and Infrastructure	Strengthens academia-industry linkages, corporate strategies, and technological innovation.
SDG 11	Sustainable Cities and Communities	Supports green energy adoption to build resilient, sustainable energy infrastructure.
SDG 12	Responsible Consumption and Production	Encourages energy efficiency, conservation, and resource-conscious industrial practices.
SDG 13	Climate Action	Promotes clean energy adoption and industry strategies to mitigate climate change impact.
SDG 17	Partnerships for the Goals	Builds collaborative, strategic alliances between academic institutions and industry leaders.

METHOD OF EVALUATION:

1. During the seminar session each student is expected to prepare and present a topic on engineering/ technology, for duration of about 8 to 10 minutes.
2. In a session of one period per week, 5 students are expected to present the seminar.
3. Each student is expected to present at least twice during the semester and the student is evaluated based on that.
4. At the end of the semester, he / She can submit a report on his / her topic of seminar and marks are given based on the report.
5. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
6. Evaluation is 100% internal.

SEMESTER 8

Course Code	Course Title	L	T	P	Total Credit
BR40002	Introduction to Switchgear and Protection	2	0	0	2

Prerequisite
Basic Electrical Engineering, Electrical Circuits, and Fundamentals of Power Systems.

Course Objectives:

To provide fundamental knowledge of electrical switchgear devices and their role in system protection. To enable students to analyze, select, and apply protective measures for safe and reliable power system operation.

Course Outcomes (COs)

CO1: Explain fundamentals of switchgear, protection systems, and electrical faults.
CO2: Identify various switchgear devices, relays, and circuit breakers used in power systems.
CO3: Analyze protection schemes for transformers, generators, feeders, and renewable energy systems.
CO4: Apply earthing, grounding, and protection coordination techniques for electrical safety.
CO5: Evaluate safety standards and protection requirements in modern renewable energy systems.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2	-	-	-	-	2	-	-	-	-	1	2	-	-	-	-
CO2	3	3	2	-	3	-	-	-	-	-	-	-	3	2	-	-	1
CO3	3	3	3	2	2	-	-	-	-	-	1	-	3	3	2	-	2
CO4	-	3	2	-	3	3	2	-	-	1	-	-	-	3	2	-	1
CO5	-	-	-	2	-	3	3	2	-	-	-	2	-	-	3	2	3
Avg	1.8	2.2	1.4	0.8	1.6	1.2	1	0.4	-	0.2	0.2	0.6	1.6	1.6	1.4	0.4	1.4

Course Contents

Unit–I: Basics of Switchgear and Protection (10 Hours)

Introduction to power system protection, Need and objectives of protection systems, Basic terminology: fault, relay, circuit breaker, isolation, Types of electrical faults (symmetrical and unsymmetrical), Protection requirements in renewable energy systems.

Unit 2: Switchgear and Protective Devices (10 Hours)

Switchgear classification: LV, MV, and HV, Fuses: types and applications, Circuit breakers: MCB, MCCB, ACB, SF_6 circuit breaker (basic concept), Relays: electromagnetic and static relays, Earthing and grounding practices.

Unit 3: Protection Schemes in Power and Renewable Energy Systems (10 Hours)

Overcurrent and earth fault protection, Protection of transformers, generators, and feeders, Basic protection of solar PV and wind energy systems, Introduction to protection coordination.

Unit 4: Electrical Safety Standards and Applications (10 Hours)

Electrical safety standards and practices, Isolation and protective equipment, Safety procedures in renewable energy systems, Hazard prevention techniques, Case studies on electrical protection and safety systems.

Textbooks

1. **Switchgear and Protection – Sunil S. Rao, Khanna Publishers**
2. **A Textbook on Power System Protection & Switchgear – R. K. Rajput, S. Chand**
3. **Power System Protection and Switchgear – Badri Ram & D. N. Vishwakarma, Tata McGraw Hill**

Reference Books

1. **Electrical Power Systems – C. L. Wadhwa, New Age International**
2. **Power System Protection and Switchgear – B. Bhalja, R.P. Maheshwari & S. R. Shah (PHI Learning)**
3. **Modern Power System Protection – D. Pavet and P. Venet, English Edition**

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Reliable and safe electrical power protection systems
8	Decent Work and Economic Growth	Skill development in protection and switchgear technologies
9	Industry, Innovation and Infrastructure	Modern electrical protection infrastructure
11	Sustainable Cities and Communities	Safe and uninterrupted electricity supply

13	Climate Action	Protection of renewable energy systems and efficient grid operation

Course Code	Subject	L	T	P	Total
BR40004	Energy Management and Auditing	2	0	0	2

Prerequisite

Basic knowledge of energy systems, electrical fundamentals, and renewable energy technologies.

Course Objectives:

To provide students with the knowledge and skills to monitor, analyze, and optimize energy use in industrial and commercial systems. Develop the ability to conduct energy audits and implement efficiency measures for sustainable energy management.

Course Outcomes (COs)

CO1: Explain the fundamentals of energy management and auditing.
CO2: Identify energy auditing methods and measurement techniques.
CO3: Analyze energy conservation opportunities in electrical and renewable energy systems.
CO4: Apply energy performance evaluation and economic analysis techniques.
CO5: Evaluate sustainable energy management practices using case studies.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	-	-	-	-	2	-	-	-	-	2	2	-	-	-	2
CO2	3	3	-	2	2	-	-	-	-	-	-	-	-	2	-	-	-
CO3	3	3	2	-	3	-	2	-	-	-	-	-	3	3	-	-	2
CO4	-	3	2	-	2	-	-	-	-	-	2	-	-	-	2	1	-
CO5	-	-	-	2	-	2	3	2	-	-	-	3	-	-	3	2	3
Avg	1.8	2.2	0.8	0.8	1.4	0.4	1.4	0.4	-	-	0.4	1	1	1	1	0.6	1.4

Course Contents

Unit 1: Fundamentals of Energy Management (10 Hours)

Global and Indian energy scenario, Energy resources and consumption patterns, Principles and objectives of energy management, Energy efficiency and conservation techniques, Role of energy managers and energy auditors.

Unit 2: Energy Auditing Techniques and Methodology (10 Hours)

Types of energy audits: preliminary and detailed audit, Energy audit methodology and procedures, Data collection methods and measurement instruments, Energy performance indicators (EnPI), Energy balance and benchmarking techniques.

Unit 3: Energy Conservation Techniques (10 Hours)

Energy conservation in electrical systems, Energy-efficient motors and drives, Efficient lighting systems and appliances, Energy management in renewable energy systems, Demand-side energy management practices.

Unit 4: Economic Analysis and Case Studies (10 Hours)

Basic cost–benefit analysis, Payback period and economic evaluation methods, Energy saving opportunities in industries and institutions, Case studies on energy auditing and management, Sustainable energy management practices.

Textbooks

1. Energy Management Principles – Craig B. Smith, Pergamon Press
2. Energy Management and Conservation – C. B. Smith & R. B. Brown, Wiley
3. Energy Audit and Management – P. R. Sukhatme, Tata McGraw Hill

Reference Books

1. Handbook of Energy Audits – Albert Thumann, William J. Younger
2. Energy Efficiency: Concepts and Calculations – Rajagopal & Srinivasan
3. Energy Management and Conservation Manual – IEA & UNEP Publications

1.

SDG Mapping

SDG	Title	Contribution

7	Affordable and Clean Energy	Efficient energy utilization and conservation
8	Decent Work and Economic Growth	Professional energy auditing and management skills
9	Industry, Innovation and Infrastructure	Energy-efficient industrial systems
12	Responsible Consumption and Production	Reduction of energy wastage through auditing
13	Climate Action	Lower greenhouse gas emissions through energy efficiency

Course Code	Course Title	L	T	P	Total Credit
BR40006	Smart Electric Grid	2	0	0	2

Prerequisite

Basic knowledge of electrical power systems, renewable energy systems, and electrical measurements.

Course Objectives:

To introduce the concepts, architecture, and components of smart electric grids with emphasis on renewable energy integration. To develop understanding of smart grid technologies, communication, automation, and grid reliability for efficient and sustainable power systems.

Course Outcomes (COs)

After completing this course, the student will be able to:

CO1: Explain the fundamentals and importance of smart grid technology.
CO2: Identify smart grid components, communication systems, and automation techniques.
CO3: Analyze renewable energy integration and energy storage in smart grids.
CO4: Apply demand response and load management concepts in smart grid systems.
CO5: Evaluate smart grid applications, challenges, and sustainable energy solutions.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2	-	-	-	-	3	-	-	-	-	2	2	-	2	-	-
CO2	3	3	2	2	-	1	3	-	-	-	-	-	2	-	3	-	2
CO3	-	3	3	2	2	-	3	-	-	-	1	-	3	2	3	-	2
CO4	-	3	-	2	-	3	3	2	-	1	-	-	-	2	3	-	2
CO5	-	2	-	-	-	2	3	2	1	2	-	2	-	-	3	2	-
Avg	1.2	2.6	1	1.2	0.4	1.2	3	0.8	0.2	0.6	0.2	0.8	1.4	0.8	2.8	0.4	1.2

Course Contents

Unit I: Fundamentals of Smart Grid (10 Hours)

Conventional grid vs smart grid, Need for smart grid in renewable energy integration, Features of smart grid: reliability, flexibility, efficiency, sustainability, Overview of Indian smart grid initiatives and policies.

Unit II: Smart Grid Components and Communication (10 Hours)

Smart meters and sensors, Advanced Metering Infrastructure (AMI), Communication technologies: PLC, GSM, Wi-Fi, IoT basics, SCADA systems and automation concepts in smart grids.

Unit III: Renewable Energy Integration and Energy Storage (10 Hours)

Integration of solar and wind energy into smart grids, Energy storage systems and battery basics, Demand response and load management techniques, Power quality and grid stability concepts.

Unit IV: Smart Grid Applications and Case Studies (10 Hours)

Applications of smart grid in smart cities and industries, Electric vehicle integration in smart grid, Cybersecurity and challenges in smart grid implementation, Case studies of smart grid projects in India.

Textbooks

1. **"Smart Grid: Fundamentals of Design and Analysis" – James Momoh**
2. **"Smart Grids: Infrastructure, Technology, and Solutions" – Stuart Borlase**

Reference Books

1. **"Smart Grid: Technology and Applications" – Janaka Ekanayake et al.**
2. **"Communication and Control in Electric Ships" – Chen-Ching Liu (for SCADA & communications)**
3. **"Renewable Energy Integration: Practical Management of Variability, Uncertainty and Flexibility" – L. Bird et al.**

SDG Mapping

SDG	Title	Contribution
7	Affordable and Clean Energy	Smart and efficient power distribution systems
9	Industry, Innovation and Infrastructure	Advanced grid technologies and automation
11	Sustainable Cities and Communities	Smart city and smart energy applications
12	Responsible Consumption and Production	Demand-side management and energy optimization
13	Climate Action	Renewable energy integration and reduced carbon emissions

Course Code	Course Title	L	T	P	Total Credit

BR40008	Environmental Impact Assessment (EIA) on Energy Conversions	2	0	0	2

Prerequisite

Basic knowledge of environmental science, renewable energy systems, and sustainability concepts.

Course Objectives:

To provide an understanding of Environmental Impact Assessment principles for evaluating the environmental effects of energy conversion systems. To develop the ability to analyze, mitigate, and manage environmental impacts of conventional and renewable energy projects for sustainable development.

Course Outcomes (COs): After completing this course, the student will be able to

CO1: Explain the fundamentals, objectives, and importance of Environmental Impact Assessment (EIA).

CO2: Analyze EIA processes, impact identification methods, and environmental regulations.

CO3: Apply Environmental Management Plan (EMP) concepts for renewable energy projects.

CO4: Evaluate environmental and social impacts of solar, wind, hydro, and biomass projects.

CO5: Assess stakeholder participation and case studies related to renewable energy EIA projects.

CO-PO-PSO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3	2	-	-	-	-	3	-	-	-	-	2	2	-	2	-	1
CO2	3	3	2	2	-	1	3	-	-	-	-	-	2	-	3	-	2
CO3	1	3	3	2	2	-	3	-	-	-	1	-	3	2	3	-	3
CO4	-	3	-	2	-	3	3	2	-	1	-	-	-	2	3	-	-
CO5	1	2	-	-	-	2	3	2	1	2	-	2	-	-	3	2	-
Avg	1.6	2.2	1	1.2	0.4	1.2	2.6	0.8	0.2	0.6	0.2	0.8	1.4	0.8	2.8	0.4	1.2

Course Contents

Unit 1: Fundamentals of Environmental Impact Assessment (10 Hours)

Environment and sustainability concepts, Need and objectives of EIA, Types of environmental impacts, Importance of EIA in renewable energy and infrastructure projects.

Unit 2: EIA Process and Environmental Regulations (10 Hours)

Screening, scoping, baseline studies, Impact identification and mitigation measures, Environmental Management Plan (EMP), Indian EIA notification and regulatory bodies.

Unit 3: EIA for Renewable Energy Projects (10 Hours)

EIA for solar, wind, hydro, and biomass energy projects, Ecological and socio-economic impacts, Environmental monitoring techniques, Sustainable mitigation practices.

Unit 4: Public Participation and Case Studies (10 Hours)

Public participation and stakeholder consultation, Environmental auditing and reporting, Case studies of renewable energy projects in India, Challenges and future scope of EIA.

Textbooks

1. **"Environmental Impact Assessment: A Practical Guide" – Subhrendu K. Pattanayak**
2. **"EIA: Theory, Methodology & Practice" – Ernest L. conway**

Reference Books

1. **"Methods of Environmental Impact Assessment" – Peter Morris & Riki Therivel**
2. **"Guidelines for EIA" – Ministry of Environment, Forest & Climate Change, Govt. of India (Latest Notification)**
3. **"Environmental Management" – B.K. Sharma**

SDG Mapping

SDG	Title	Contribution
6	Clean Water and Sanitation	Assessment of water impacts in energy projects
7	Affordable and Clean Energy	Sustainable renewable energy project planning
11	Sustainable Cities and Communities	Environmentally responsible infrastructure development
12	Responsible Consumption and Production	Sustainable environmental management practices
13	Climate Action	Climate-sensitive energy planning and mitigation measures



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