NAAC Criteria -1.3: Curriculum Enrichment

1.3.1 The Institution integrates cross- cutting issues relevant to Professional Ethics, Gender, Human Values, Environment and Sustainability into the Curriculum

Cross-cutting issues addressed through SPPU curriculum

1.3.1.D. Environment and Sustainability

203152 : Audit Course-III

List of three audit course is provided. Students can choose any one from 203152(A) 203152(B) and 203152(C)

203152 (A) : Solar Thermal System

Teaching Scheme	Credits	Examination Scheme [Marks]
Lectures: 2hrs/week	**No credit**	**Grade: PP/NP** **Quiz and term paper**

Description: The course will introduce the basics of: solar energy, availability, applications, heat transfer as applied to solar thermal systems, various types of solar thermal systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The following topics may be broadly covered in the classroom. The field visits will be designed for first-hand experience and basic understanding of the system elements.

Course Objective:

- To understand basics and types of solar thermal systems.
- To get knowledge of various types of concentrators.
- To make students aware of different Standards and certification for Concentrator Solar Power.

Course Outcome: Student will be able to

CO1: Differentiate between types of solar Concentrators

CO2: Apply software tool for solar concentrators

CO3: Design different types of Solar collectors and balance of plant

Course Contents:

- Sun, Earth and seasons
- Solar Radiation
- Basics of heat transfer
- Absorption, reflection and transmission of radiation
- Types of Solar thermal systems
- Basic design of different types of systems
- Applications of solar thermal systems and their economics
- Need for solar concentration
- Various types of solar concentrators
- Movement of Sun and tracking
- Control systems for solar tracking
- Concentrating solar thermal (CSP)
- Concentrating solar PV (CPV)
- Balance of plant for CSP
- Critical points in concentrating solar system installation
- Operation and maintenance of CSP
- Typical financial analysis of CSP
- Software tools for concentrating solar power
- Environmental impact assessment
- Standards and certification for CSP
- Basics of solar thermal (STH) systems
- Elements of various STH systems
- Design, materials and manufacturing of
  - Flat plate solar collector
  - Evacuated tube solar collector
  - Parabolic trough collector
  - Dish type solar concentrators
  - Concentrating PV systems
  - Balance of plant
- Manufacturing standards

- Quality assurance and standards
- Certification
- Special purpose machines and Automation in manufacturing
- Site assembly and fabrication
- Typical shop layouts
- Inventory management
- Economics of manufacturing

Assignment

- Design of solar thermal system for residential/ commercial building.

References:

1. Trainers Textbook Solar Thermal Systems Module, Ministry of New and Renewable Energy, Government of India
2. Students Workbook for Solar Thermal Systems Module, Ministry of New and Renewable Energy, Government of India

203152 (B) : C Language Programming

Teaching Scheme Lectures: 2hrs/week	Credits No credit	Examination Scheme [Marks] Grade: PP/NP Quiz and term paper

Course Objective:

- To give basic idea about C programming language
- To prepare students for writing algorithm, draw flow chart and program in C language
- To learn data types and syntax in C language.

Course Outcome: Student will be able to

CO1: Elaborate data types, arithmetic, logical and conditional operators

CO2: Apply control and looping statements in C programming

CO3: Write programming using C language with functions, arrays and pointers.

Course Contents:

Unit 01: The language of C : Phases of developing a running computer program in C, Data concepts in C :Constants, Variables, Expressions, Operators, and operator precedence in C., Statements : Declarations, Input-Output Statements, Compound statements, Selection Statements. Conditions, Logical operators, Precedence. Repetitive statements, While construct, Do-while Construct, For construct., Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow., Arrays. Strings. Multidimensional arrays and matrices.

Unit 02: Functions :The prototype declaration, Function definition.Function call : Passing arguments to a function, by value, by reference. Pointers : Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer

Assignment

- Write C program for arithmetic operations such as +,-,*,/,%.
- Write C program for decision making statements such as if, else-if etc.
- Write C program for Representative statements such as for, while, do-while.
- Write C program to determine roots of an quadratic equation using functions.
- Write C program to enter matrix data and printing its inverse.
- Write C program to demonstrate use of pointers.

References:

1. A.R. Bradley, "Programming for Engineers", Ringer, 2011
2. Hankering and Chitchat, "The C Programming Language", (2nd ed.) Prentice Hall, 1988

203152(C) Japanese Language-I

Teaching Scheme Lectures: 2hrs/week	Credits No credit	Examination Scheme [Marks] Grade: PP/NP Quiz and term paper

Course Objective:

- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcome: On completion of the course student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- Will develop interest to pursue professional Japanese Language course.

Course Contents:

Unit 1: Introduction to Japanese Language. Hiragana basic script, colors, Days of the week

Unit 2: Hiragana: modified Kana, double consonant, Letters combined with ya, yu, yo Long vowels, Greetings and expressions

Unit 3: Self Introduction, Introducing other person, Numbers, Months, Dates, Telephone numbers, Stating one's age.

References:

1. Minna No Nihongo, "Japanese for Everyone", Elementary Main Text book 1-1 (IndianEdition), Goyal Publishers & Distributors Pvt. Ltd.

Guidelines for Conduction

(Any one or more of following but not limited to)

- Guest Lectures
- Visiting lectures
- Language Lab

Guidelines for Assessment (Any one of following but not limited to)

- Written Test
- Practical Test
- Presentation
- Paper
- Report

203153: Audit Course-IV

List of three audit course is provided. Students can choose any one from 203153(A) 203153(B) and 203153(C)

203153(A): Solar Photovoltaic Systems

Teaching Scheme	Credits	Examination Scheme [Marks]
Lectures: 2hrs/week	**No credit**	**Grade: PP/NP** **Quiz and term paper**

Prerequisite: Completion of FE or equivalent

Description: The course will introduce the basics of: solar energy, availability, semiconductors as photovoltaic convertors and solar cells, applications of photovoltaic, various types of solar photovoltaic systems, and introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The following topics may be broadly covered in the classroom. The practical will be designed for basic understanding of the system elements.

Course Objective:

- To learn Solar PV system and its appliances
- To get knowledge of balance of PV system, batteries, inverters etc.
- To understand grid tied SPV solar plants

Course Outcome: Students will be able to

CO1: design of Solar PV system for small and large installations

CO2: handle software tools for Solar PV systems

Course Contents:

- Physics of photovoltaic (PV) electricity
- Photodiode and solar cell
- Solar radiation spectrum for PV •
- Types of solar cell and comparison
- Introduction to various types of solar module manufacturing
- Basic system design and economics
- Types of systems
- Common applications of solar PV
- Introduction to solar PV (SPV) systems
- SPV appliances
- Small capacity SPV power plants
- Grid tied SPV power plants
- Large scale SPV power plants
- Balance of system
- Solar inverters
- Batteries
- Financial modelling of SPV
- Operation and maintenance of SPV
- Software tools for SPV
- Environmental impact assessment
- Standards and certification for SPV
- Basics of SPV systems
- Elements of SPV appliances and power plants Procurement versus production
- Bought-outs, assemblies, sub-assemblies
- Manufacturing and assembly
- Manufacturing standards
- Quality assurance and standards
- Certification
- Special purpose machines and Automation in manufacturing
- Site assembly and fabrication

- Typical shop layouts
- Inventory management
- Economics of manufacturing

Practical:

- PV characterization
- Batteries and energy storage
- PV system design

Assignment

- Design of solar PV system for department / college.

References:

[1] A.S.Kapur -A Practical Guide for Total Engineering of MW capacity Solar PV Power Project
[2] Solanki C.S- Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers- PHI
[3] Solanki C.S- SolarPhotovoltaics - Fundamentals, Technologies and Applications- PHI
[4] S. Sukhatme -Solar Energy : Principles of Thermal Collection and Storage- McGraw Hill

203153(B) Installation & Maintenance of Electrical appliances

Teaching Scheme Lectures: 2hrs/week	Credits No credit	Examination Scheme [Marks] Grade: PP/NP Quiz and term paper

Prerequisite: Completion of FE/DEE or equivalent

Course Objective: This course has been designed to provide the knowledge of Repairing and Maintenance of home appliances. Students will be familiar with maintenance of everyday household necessities.

Course Outcome: At the end of the course the students will be having knowledge of: -

- Observing the safety precautions while working,
- Test line cord for continuity with test lamp/ multimeter
- Dismantle and reassemble an electric iron
- Heater, kettle, room heater, toaster, hair dryer, mixer grinder etc.
- Install a ceiling fan and the regulator
- Check a fluorescent lamp chock, starter and install it
- Domestic installation testing before energizing a domestic installation

Course Contents:

- General safety & electrical safety
  - What is safety, Why safety is needed
  - Tools for electrical safety
  - Safety rules
  - Precaution during electrical maintenance
- Crimping & crimping tool, soldering
  - What is crimping, crimping tool, How to use RJ-11 connector, telephone wire, UTP Cable
  - crimping technique, precaution during crimping
  - Soldering Iron, Soldering wire, Soldering Flux,
  - Soldering method, Zero defect soldering
- Earthing& types of Earthing
  - Introduction of Earthing
  - Need of Earthing, Hazard
  - Types of Earthing
  - Advantage of Earthing, working of Earthing
- Simple house wiring circuit
  - Introduction of Wiring ,types of wiring
  - need of wiring, advantage of wiring
  - wiring methods
  - electrical panel
  - cable type
- Install, service and repair of automatic electric iron, mixer grinder, ceiling and table fan, heater, iron, kettle, washing machine etc
  - Installation procedure of electric iron,
  - Installation procedure mixer grinder
  - Installation procedure of ceiling and table fan,
  - Installation procedure heater, iron, kettle
  - Installation procedure washing machine
  - fault finding & removal of faulty component in electric iron, mixer grinder, ceiling and table fan
  - fault finding & removal of faulty component in heater, iron, kettle, washing machine
- Assemble and install of a fluorescent lamp
  - Parts of fluorescent lamp,
  - Working principle of fluorescent lamp

- Assembling procedure of lamp

- Thermostat heat controls of Automatic electric iron, steam iron, spray irons.
  - Thermostat, Bimetal, Wax Pallet , Gas Expansion, Pneumatic,
  - Bimetallic Switching thermostat, Simple two wire thermostats
  - Combination heating/Cooling regulation, Heat Control of Steam Iron, Electric Iron
- Maintenance of decorative serial lamp for a required supply voltage
  - What is decorative lamp, Working of decorative lamp
  - Description of decorative serial lamp,
  - Maintenance of decorative serial lamp
- Introduction to re- winding Insulating material used
  - Material, Types of Material
  - Insulating Material, Types of Insulating Material
  - Need of insulating material, winding, re-winding

References:

[1] S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House
[2] B. K. N. Rao -Hand book of condition monitoring- Elsevier Advance Tech., Oxford (UK).
[3] Eric Kleinert-Troubleshooting and Repairing Major Appliances / Edition 3- McGraw Hill
[4] Service Manual of Electrical Home Appliances

203153(C) Japanese Language-II

Teaching Scheme Lectures: 2hrs/week	Credits No credit	Examination Scheme [Marks] Grade: PP/NP Quiz and term paper

Course Objective:

- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcome: On completion of the course student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- Will develop interest to pursue professional Japanese Language course.

Course Contents:

Unit 1: Katakana basic Script, Denoting things (nominal & prenominal demonstratives)Purchasing at the Market / in a shop / mall (asking & stating price)

Unit 2: Katakana: Modified kana, double consonant, letters with ya, yu, yo, Long vowelsDescribing time, describing starting & finishing time (kara ~ made) Point in time (denoting the time when any action or the movement occurs)

Unit 3: Means of transport (Vehicles), Places, Countries, Stating Birth date, Indicating movement to a certain place by a vehicle

References:

1. Minna No Nihongo, “Japanese for Everyone”, Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.

Guidelines for Conduction

(Any one or more of following but not limited to)

- Guest Lectures
- Visiting lectures
- Language Lab

Guidelines for Assessment (Any one of following but not limited to)

- Written Test
- Practical Test
- Presentation
- Paper
- Report

303151D:Elective-II Energy Management

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

Various electrical equipment and specifications, Construction and operation of different equipment/process like HVAC, Pumps, Compressors etc.

Course Objectives: The course aims to:-

1. Understand importance of energy Conservation and energy security and impact of energy use on environment
2. Follow format of energy management, energy policy.
3. Understand demand side management tools and impact of tariff on demand management
4. Importance of Data Analytics in Energy audit and audit process
5. Calculate energy consumption and saving options with economic feasibility.
6. Use of appropriate energy conservation measure in field applications or industry.

Course Outcomes: At the end of this course, student will be able to

CO1	Describe BEE Energy policies, Energy ACT.
CO2	List and apply demand side management measures for managing utility systems
CO3	Explore and use simple data analytic tools.
CO4	Use various energy measurement and audit instruments.
CO5	Evaluate economic feasibility of energy conservation projects
CO6	Identify appropriate energy conservations methods for electric and thermal utilities

Unit 01 Energy Scenario — 06 hrs

Classification of Energy resources, Commercial and noncommercial sources, primary and secondary sources, commercial energy production, final energy consumption. Energy needs of growing economy, short terms and long terms policies, energy sector reforms, energy security, importance of energy conservation, energy and environmental impacts, introduction to CDM, UNFCCC, Paris treety, emission check standard, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Latest amendments in Electricity Act. Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC).

Unit 02 Energy Management — 06 hrs

Definition and Objective of Energy Management, Principles of Energy management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under the latest Act. Energy Efficiency Programs. Energy monitoring systems.

Unit 03 Demand Management — 06 hrs

Supply side management (SSM), Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and barriers, implementation of DSM. Use of demand side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD). Power factor penalties and incentives in tariff for demand control. Apparent energy tariffs. Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind, etc.) Introduction to ISO 50001- Energy Management.

Unit 04 Energy Audit — 06 hrs

Definition, need of energy audits, types of a ollow, data and information analysis, Introduction to Data Analytics , data qua istering techniques, pattern mining,

regression and classification. Relevance of Data Analytics in Audit, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit reporting format – Executive Summary , Detailing of report.

Unit 05	**Financial Analysis**	**06 hrs**

Financial appraisals; criteria, simple payback period, return on investment, net present value method, time value of money, break even analysis, sensitivity analysis and numerical based on it, cost of energy, cost of generation Energy Audits case studies – Sugar Industry, Steel Industry, Paper and Pulp industry.

Unit 06	**Energy Conservation**	**06 hrs**

a) Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and steam systems) d) Ventilation(Fan, Blower and Compressors) and Air Conditioning systems e) Pumping System f) Cogeneration and waste heat recovery systems g) Utility industries (T and D Sector) and Performance Assessments.

Test Books:

[T1]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 1, General Aspects (available on line)
[T2]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available on line)
[T3]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available on line)
[T4]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available on line)

Reference Books:

[R1]	Success stories of Energy Conservation by BEE (www. Bee-india.org)
[R2]	Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.
[R3]	Energy Management by W.R. Murphy and Mackay, B.S. Publication.
[R4]	Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication
[R5]	Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.
[R6]	A General Introduction to Data Analytics by Andre Carvalho and Tomáš Horváth Wiley Inc First Edition 2019.

Online Resources:

[O1]	www.energymanaertraining.com
[O2]	www.em-ea.org
[O3]	www.bee-india.org
[O4]	https://www.iso.org/iso-50001-energy-management.html

Unit	**Text Books**	**Reference Books**
Unit 1	T1	O1, O2
Unit 2	T1	O1, O2
Unit 3	T1	R4, O4
Unit 4	T1	R4, R5 and O1 and O2 R6
Unit 5	T1 and T4	R1, R2, R3, R5 O1 and O2
Unit 6	T2, T3 and T4	R1, R5 and O1 and O2

303147A: Audit Course V: Energy Storage System

Teaching Scheme			Credits		Examination Scheme	
Theory	02	Hr/Week	**TH**	00	**GRADE**	PP/NP

Prerequisite:

Batteries, Inductor and Capacitor

Course Objectives:

To elaborate various energy storage systems
To be familiar with various aspects such as hybridization, selection of storage system.

Course Outcomes: At the end of this course, student will be able to

CO1	Explain and differentiate various types of energy storage for suitable applications
CO2	Understand battery recycling techniques

Unit 01 **Energy Storage Fundamentals** **05 hrs**

(A) Battery : Energy Density, Power Density, Cycle life, C-rate, State of Charge (SoC), State of Health (SoH), Depth of Discharge (DoD), Characteristic.
(B) Types of Batteries, : Nickel Metal Hydrate, Nickel Cadmium, Lithium ion, Lithium Polymer, Flow Batteries (Vanadium, Zinc, Manganese)
(C) Supercapacitor, Superconducting Magnetic Energy Storage, Compressed Air Energy Storage, Flywheel storage
(D) Hybridization of energy storage
Energy storage sizing, Selection of storage as per application

Unit 02 **Recent Trends in Storage** **05 hrs**

Solid state batteries, Aluminum air and Aluminum ion batteries, Lithium ion Capacitor, Advances in Thermal energy storage systems.Batteries recycling techniques and policies, Case studies.

Reference Books:

[R1]	Handbook of Energy Storage: Demand, Technologies, IntegrationMichael Sterner, Ingo Stadler
[R2]	Energy Storage: Fundamentals, Materials and Applications, Robert Huggins

Industrial Visit : Manufacturing industry of battery or Capacitor

303147B: Start-up and Disruptive Innovations

Teaching Scheme			Credits		Examination Scheme	
Theory	02	Hr/Week	**TH**	00	**GRADE**	PP/NP

Prerequisite:

Course Objectives:

Course Outcomes: At the end of this course, student will be able to

CO1	Describe role of incubation for Startup and recent national policy.
CO2	Identify various types of Startups.
CO3	Explain impacts of disruptive innovation and Differentiate between disruptive innovation and disruptive technology

Unit 01	**Start-up**	**05 hrs**

Startup Fundamentals

Startup: Stages of startup life cycle, business model, business plan, Business incubation, Startup financing life cycle, Funding options for startup, Market, Market Segments.

Entrepreneurship: Types of Entrepreneurship : Social, Rural, Women, Agri-preneurship. Factors affecting Entrepreneurship Growth

Government Initiatives and Policies

Initiatives taken by the government, Startup India Scheme, National Innovation and Startup Policy 2019, Approvals and other regulatory processes, Challenges faced by startups in India, Students Startup, Faculty Startup.

Types of Stratups and Case Studies

Types of Startups : E-commerce Startups, EdTech Startups, FinTech Startups, Food and Beverages Startups, Health Care Startups, Blockchain Startups etc.

Case study : Airbnb, Paytm, Byju, Zomato, Red bus, Ola, Razorpay

Unit 02	**Disruptive Technologies**	**05 hrs**

Disruptive Innovation Fundamental

What is invention? What is innovation?, Defining Disruptive Innovation, Sustaining Innovation, Disruptive Innovation Theory, Disruptive innovation model, Disruptive strategy, Impact of Disruptive Innovation, Requirements of Disruptive Innovation, Types of Disruptive Innovations.

Inventor vs. Entrepreneur vs. Manager: Schumpeter's Trumpeters

Schumpeter's "creative destruction"

Maslow's Hierarchy of Needs Revisited , Disrupting Brands , Disrupting Religion.

Disruptive Technologies

Agricultural Revolution, Scientific Revolution, Industrial Revolution, Digital Revolution

Disruptive Innovation Vs Disruptive Technology

IoT, AI, Cloud Computing, Digital Twin, CRISPR, Blockchain, 3D printing, Advanced Energy Storage, Hyperloop, Autonomous Vehicles, Nano technology, Industrial Automation (Industry 4.0)

Reference Books:

[R1]	The $100 Stratup : Reinvent the Way you Make a Living, Do What You Love and Create a New Future, Chris Guillebeau
[R2]	Creating a Successful Business Plan. Entrepreneur Magazine
[R3]	Thomas Kuhn and The Theory o ons revisited, CRC Press
[R4]	P. Armstrong. Disruptive Tech d, Evaluate, Respond Kogan Page Publishers. (2017)
[R5]	Innovator's Solution: Creating a ssful Growth – Clayton Christensen, 16 December 2013

[R6]	Digital Disruption: Unleashing the Next Wave of Innovation – James McQuivey, 26 February 2013
Online Resources:	
[O1]	https://ipindia.gov.in/
[O2]	https://www.wipo.int/about-ip/en/
[O3]	https://www.weforum.org/agenda/2016/06/what-is-disruptive-innovation/

403147C: Sustainability

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	–	ISE		–

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Course Objectives:

This course aims to:

- Increase awareness among students about sustainability.
- Understand role of engineering and technology within sustainable development.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Understand different types of environmental pollution problem.
CO2: Suggest solutions for sustainable development.
CO3: Develop a broader perspective in thinking for sustainable practices by utilizing engineering principle and knowledge

Unit 01	Sustainability Introduction		11 hrs

Introduction, need and concept of sustainability, social, environmental and economical sustainability concepts, sustainable development, 17 goals defined by UN, Nexus between technology and sustatinable development and its challenges, multilateral environmental agreements and protocols-CDM, Environmental legislations in India-Water Act, Air Act.
Air, water and solid waste pollution sources and impacts, Sustainable water treatment. Zero waste concept. Global environmental issues, climate change, global warming, ozon layer depletion.

Unit 02	Sustainable Solution		11 hrs

Carbon credits and trading, carbon foot print, Green engineering, sustainable urbanization, industrialization and poverty reduction, Industrial process: Material selection, pollution preventions, industrial ecology and symbiosis, Global institutions: UNEP, IPCC, UNDP, WHO, Kyoto protocols. Certification and labelling in energy and carbon: Energy Star, Compliance and voluntary carbon credits, Green-e. Tools and techniques: ISO 14001, ISO26000, ABCD planning method.Assessment measurement: Indicators, F2B2, LCA, LCC, ROI.

Text Books:

[T1]	Allen D. T. and Shonnard D. R. “Sustainable Engineering: Concept design and case studies”, Prentice hall
[T2]	Environmental Impact Assessment Guidelines, Notification of Government of India 2006
[T3]	Mackenthun K. M. “Basic Concept anagement”, Lewis publication London 1998
[T4]	ECBC code 2007, BEE, New Delhi ERI publication

[T5]	Ni Bin Chang, “Systems Analysis for sustainable engineering: Theory and Applications ”, Mc-Graw-Hill Professional
Reference Books:	
[R1]	“Sustainable Excellence Associate: Study Guide” International society of sustainability professional, https://community.sustainabilityprofessionals.org/store/viewproduct.aspx?id=13043928
Online Resources:	
[O1]	https://www.globalgoals.org/goals/

403153C: GREEN BUILDING

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	--	ISE		--

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Course Objectives:

This course aims to:

- To learn the principles of planning and orientation of buildings.
- To acquire knowledge on various aspects of green buildings.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Design green and sustainable techniques for both commercial and residential buildings.
CO2:Design water, lighting, energy efficiency plan using renewable energy sources.
CO3:Explain the principles of building planning, its bylaws and provide facilities for rainwater harvesting
CO4:Understand the concepts of green buildings

Unit 01	Sustainability and Building design	06 hrs

Sustainability, objectives of sustainable development, Sustainable aspects of habitat design, sustainable buildings, principles, approaches and characteristics, climate data, climate parameters and zones, comparative analysis of various climatic zones, site planning recommended checklist for identifying site characteristics, site development and layout. Efficient water management and waste water treatment, solid waste management.

Unit 02	Energy efficiency	06 hrs

Solar passive techniques in building design to minimize load on conventional systems i.e. heating, cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use of renewable energy systems to meet part of building load. Green building certification. Overview of various green buildings in India. Policy and regulatory mechanisms.

Text Books:

[T1]	Seven Wonders of Green Building Technology: Karen Sirvaitis, Twenty-First Century Books.
[T2]	Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.
[T3]	Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.
[T4]	Fundamentals of Integrated Design ding By Marian Keeler, Bill Burke

Reference Books:

[R1]	Sustainable Building Design Manual, Volume 2, TERI, New Delhi
[R2]	Energy Efficient Buildings in India, TERI, New Delhi
[R3]	Sustainable Building Design Manual, Volume 1 TERI, New Delhi
[R4]	Mili Majumdar, “Energy-efficient buildings in India” Tata Energy Research Institute, 2002.
[R5]	TERI “Sustainable Building Design Manual- Volume I & II” Tata Energy Research Institute, 2009.
Online Resources:	
[O1]	https://nptel.ac.in/courses/105102175
[O2]	https://theect.org/energy-efficiency-buildings-distance-learning/
[O3]	https://www.udemy.com/topic/energy-management/
[O4]	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce13/
[O5]	https://beeindia.gov.in/content/certification
[O6]	https://elearning.iea.org/
[O7]	https://onlinecourses.nptel.ac.in/noc20_ce08/preview

403144B: Electric and Hybrid Vehicle

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Tutorial	02	Hrs/Week/Batch	Tutorial	01	ESE	70
					Term work	25

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Course Objectives:

This course aims to:
1. To gain knowledge of Li-ion battery protection.
2. To learn HEV Subsystems and Configurations.
3. To understand Mathematical Model of Li-ion battery.
4. To familiarize with Hybridization of drivetrains.
5. To learn Star Labeling Schemes for Li-ion Packs.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Analyze the Life Cycle Assessment of Li-ion battery.
CO2 : Describe the different types of Li-ion charging methods
CO3 : Comprehend the knowledge of drivetrain hybridization.
CO4 : Evaluate EV motor sizing.
CO5 : Classify Battery Recycling methods.

Unit 01	Li-ion Battery	07 hrs

Materials used for Li-ion battery, Nanostructured Electrode Materials for Li-Ion Batteries, Li-ion battery protection, Wireless charging of EV, Life Cycle Assessment of Li-ion battery, Solid-state Battery, Panasonic 18650 & 2170 cell,

Unit 02	Battery Charging and Modelling	07 hrs

TSCC/CV charging and CVCC/CC charging of Li-Ion battery, BMS standards,
SoC Estimation methods (Kalman Filter, Neural Network, Fuzzy logic), Public EV charging stations, Solar Powered Charging Stations, Modeling of Lithium-ion batteries, Thermal Modeling of Li-ion battery.

Unit 03	Electric Vehicle Technologies	07 hrs

Battery Swapping System, EV Fleet Management, Sensors for Electric Vehicles
Electric bus, Electric trucks, Fuel cell vehicles, Introduction of EV Subsystems and Configurations, Energy management strategies and its general architecture.

Unit 04	Plug-In Hybrid Electric Vehicles	07 hrs

Hybridization of drivetrains in HEVs, Hybridi ces in EVs, Power Flow control in hybrid drive train topologies, Power Managem V, Introduction of HEV Subsystems and Configurations, Vehicle Dynamics Fund Modeling (Series Hybrid), Fuel

efficiency analysis.		
Unit 05	EV Components Design	07 hrs
Criteria for battery selection , Forces on EV calculation, Power for EV calculation, Sizing the Power Converter, Sizing of Electric Machine for EVs and HEVs, Motor Torque Calculation, Induction motor control, PMSM motor control, Battery pack design, In vehicle networks- CAN		
Unit 06	Electric Vehicle Policies and Startups	07 hrs
FAME-II Policy , Charging Infrastructure for Electric Vehicles - Revised Guidelines and Standards , Star Labeling Schemes for Li-ion Packs- BEE India, EV Tariff, EV Startup examples, Li-ion Battery Recycling Policy and Standards		

Text Books:

[T1]	Energy Systems for Electric and Hybrid Vehicles Edited by K.T. Chau
[T2]	Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011
[T3]	Electric and Hybrid Vehicles by Tom Denton

Reference Books:

[R1]	Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010
[R2]	James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003..

Online Resources:

[O1]	NPTEL Course : Electric Vehicles - Part 1 by Prof. Amit

List of Tutorials:

Any 8 of the following

1. Introduction to battery modeling MATLAB Simulink
2. Introduction to BLDC motor control MATLAB Simulink
3. Introduction to Induction Motor control MATLAB Simulink
4. Power Converter selection in MATLAB Simulink
5. Study of EV subsidies in different states.
6. Visit to the Electric Vehicle Charging Station.
7. Study of Thermal Modeling in Ansys software
8. Study of Harmonics issues of EV charging.
9. Fuel efficiency evaluation of a series HEV in city and high-way.
10. Various strategies for improving vehicle energy/fuel efficiency regenerating braking.
11. Study of various Battery Recycling Methods.

Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate not
- Timely submission of tutorials.
- Assessment of the report must be base presentation and contents.

Selecting an Audit Course:

Using NPTEL Platform:

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Student can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with certificate.

Assessment of an Audit Course:

- The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.
- During the course students will be submitting the online assignments. A copy of same students can submit as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the marksheet.

Savitribai Phule Pune University

Second Year of Electronics / E & Tc Engineering (2019 Course)

204191: Signals & Systems

Teaching Scheme:	Credit	Examination Scheme:
Theory: 03 hrs. / week **Tutorial: 01 hr. / week**	**03 + 01 = 04**	**In-Sem (Theory): 30 Marks** **End Sem (Theory): 70 Marks** **Term Work: 25 Marks**

Prerequisite Courses, if any: --

Companion Course, if any: 204195 - Signal & Control Systems Lab

Course Objectives:

- To understand the mathematical representation of continuous and discrete time signals and systems.
- To classify signals and systems into different categories.
- To analyze Linear Time Invariant (LTI) systems in time and transform domains.
- To build basics for understanding of courses such as signal processing, control system and communication.
- To develop basis of probability and random variables.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Identify, classify basic signals and perform operations on signals.

CO2: Identify, Classify the systems based on their properties in terms of input output relation and in terms of impulse response and will be able to determine the convolution between to signals.

CO3: Analyze and resolve the signals in frequency domain using Fourier series and Fourier Transform.

CO4: Resolve the signals in complex frequency domain using Laplace Transform, and will be able to apply and analyze the LTI systems using Laplace Transforms.

CO5: Define and Describe the probability, random variables and random signals. Compute the probability of a given event, model, compute the CDF and PDF.

CO6: Compute the mean, mean square, variance and standard deviation for given random variables using PDF.

Savitribai Phule Pune University, Pune
TE Civil (2019 Pattern) w. e. f. June 2021
301011 a: Audit Course I: Professional Ethics and Etiquettes

Teaching scheme	Credit	Examination scheme
Tutorial: 01 Hours/week	--	Grade

Professional ethics is the underlying concept behind the successful accomplishment of any act of a professional towards achieving the individual and societal goals. These goals should ultimately result in morally, legally, ethically and even culturally acceptable good things for all. Engineers being special group of professionals need to be more conscious of their acts since their duties, rights and responsibilities permeate into the society and the surroundings. To practice professional ethics, understanding of values and concepts are essential.

Course objectives

01 To create awareness on professional ethics and human values.
02 To provide basic familiarity about Engineers as responsible experimenters, research ethics, codes of ethics, industrial standards.
03 To inculcate knowledge and exposure on safety and risk.
04 To expose students to right attitudinal and behavioral aspects.

Course outcomes

On successful completion of this course, the learner will be able to:

01 Understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories
02 Understand various social issues, industrial standards, code o ethics and role of professional ethics in engineering field.
03 Follow ethics as an engineering professional and adopt good standards and norms of engineering practice.
04 Apply ethical principles to resolve situations that arise in their professional lives

Course Contents

Unit I: Human Values and Engineering Ethics

Morals, values and ethics, integrity, work ethic, civic virtue, valuing time, cooperation, commitment, empathy, self-confidence, stress management, senses of engineering ethics, Kohlberg's theory, Gilligan's theory, models of professional roles, uses of ethical theories.

Unit II: Research Ethics and Codes of Ethics

Industrial standardization, ethical code and its importance, ethical accountability, law in engineering and engineering as social experimentation.

Unit III: Safety, Responsibilities and Rights

Safety and risk, assessment of safety and risk, risk benefit analysis and reducing risk collegiality, collective bargaining, confidentiality, conflicts of interest, professional rights, employee rights, intellectual property rights(IPR), discrimination and utilitarianism.

Unit IV: Professional Etiquette

Etiquette at meetings, public relations ettes, technology etiquette phone etiquette, email etiquette, social media onferencing etiquette, interview

etiquette, dressing etiquettes : for interview, offices and social functions, ethical values: importance of work ethics.

Reference books

01 Ethics in Engineering Practice and Research, Caroline Whitbeck, Cambridge Press
02 Intellectual Property Rights, Prabhuddha Ganguli, Tata Mc-Graw –Hill, New Delhi.
03 Professional Ethics and Etiquette (Mastering Career Skills), Checkmark
04 Professional Ethics And Human Values, A Alavudeen, Firewall

Savitribai Phule Pune University, Pune
TE Civil (2019 Pattern) w. e. f. June 2021
301021 b: Audit Course II: Industrial Safety

Teaching scheme	Credit	Examination scheme
Tutorial: 01 Hours/week	--	Grade

Course objectives

01 Health environment and security covers virtually every important area in administration

Course outcomes

On successful completion of this course, the learner will be able to:

01 Analyze the safety problem with its solution

Course Contents

Unit I: Introduction of safety

Elements of safety programming, safety management, upgrading developmental programmers: safety procedures and performance measures, education, training and development in safety.

Unit II: Safety Performance Planning Safety Performance

An overview of an accident, it is an accident, injury or incident, the safety professional, occupational health and industrial hygiene, understanding the risk, emergency preparedness and response, prevention of accidents involving hazardous substances.

Unit III: Accident Prevention

What is accident prevention, maintenance and inspection, monitoring techniques, general accident prevention, safety education and training.

Unit IV: Safety Organization

Basic elements of organized safety, duties of safety officer, safe work practices, safety sampling and inspection, job safety analysis (JSA), safety survey, on-site and off-site emergency plan, reporting of accidents and dangerous occurrences.

Reference books

01 Industrial Safety, Health Environment and Security, Basudev Panda, Laxmi Publications

02 Industrial safety and Environment, A. K. Gupta, Laxmi Publication

03 Industrial Safety Management, L. M. Deshmukh, Tata McGraw-Hill

Guidelines for Conduction (Any one or more of following but not limited to)

1. Guest Lectures.
2. Visits to sites
3. Studying reports of case studies

Guidelines for Assessment (Any one of following but not limited to)

1. Written Test
2. Practical Test
3. Presentation
4. Repor

Savitribai Phule Pune University, Pune
TE Civil (2019 Pattern) w. e. f. June 2021
301015 f: Elective II: Solid Waste Management

Teaching scheme	Credit	Examination scheme
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites

Fundamentals of Environmental Studies, Engineering Chemistry and Waste Water Engineering

Course objectives

01 To understand problems of solid waste, estimate and characterize the solid waste and apply the knowledge of laws for municipal solid waste management for handling of MSW.

02 To understand government initiatives for management of solid waste, to apply the knowledge of mathematics, science, and engineering for effective solid waste collection systems, for waste collection route optimization and its economics.

03 To understand processing of solid waste, material recovery facility and to design composting systems, maintain and operate composting process for effective organic waste recycling.

04 To understand working of waste to energy system and to design of bio-methnation and incineration system.

05 To design & manage construction and operations of landfill facilities and management of legacy solid waste.

06 To understand management and legal requirements of special waste and reuse, recycle and material recovery from solid waste.

Course outcomes

On successful completion of this course, the learner will be able to:

01 Outline solid waste management systems with respect to its generation rate (quantity), sampling, characteristics and regulatory/legal requirements.

02 Explain and suggest relevant method of storage, collection and transportation of solid waste for the given site condition with justification.

03 Develop understanding of technological applications for processing and material recovery from solid waste with its economics and design composting system for organic waste.

04 Describe the fundamental and technological aspects of waste to energy systems from solid waste and to design anaerobic digester and incineration system.

05 Outline the design, operation, and maintenance of sanitary landfill and management of legacy waste.

06 Explain the functional element for ı ial waste and suggest the relevant method of reuse and recycling for t te in the given situation.

Course Contents

Unit I: Introduction to Solid Waste Management (06 Hours)

Definition, objectives of SWM, impacts of improper SWM: soil, water and air, functional outlines of SWM, sources and types of solid waste. MSW: sampling, refuse analysis, composition, characteristics: physical, chemical, biological and generation rate, factors affecting generation rate, estimation of quantity of solid waste. Sustainable solid waste management for smart cities, role of urban local bodies in waste management, objectives and importance of MSW Rules 2016, rules and regulations of SWM in developed countries.

Unit II: Government Initiatives, Collection & Transportation of Solid Waste (06 Hours)

Swachh survekshan and its impact on the SWM scenario in India, national urban livelihood missions (NULM) and its role in SWM, social entrepreneurship, swachhta & rural engagement cell (SESREC): government of India initiatives, success stories of SWM in India. Integrated solid waste management, storage, different methods of collection, collection systems, transfer and transportation of solid waste, uses of radio frequency identification (RFI)/global positioning system (GPS) for tracking vehicles location, optimization of route, measurement and methods of measuring solid waste, economics of solid waste collection and transport.

Unit III: Processing and Transformation of Solid Waste (06 Hours)

Decentralised system Vs centralised system, three tier system, source reduction, segregation and salvage, material recovery facility centres, resource recovery of bye-products, recycling and reuse of solid waste, use of solid waste as raw materials in industry, value added products, recycling and carbon credits, economics of solid waste processing, circular economy in waste management. Theory of composting, processing before composting, types of composting (home composting, vermicomposting, organic waste converter, rotary drum, continuous flow reactor), explain methods: Indore method, Bangalore method, mechanical composting plant, factors governing composting and design of composting system.

Unit IV: Waste to Energy (06 Hours)

Bio-methnation: theory of anaerobic digestion, stages, factors affecting anaerobic digestion, recovery of bio-gas, applications/use of biogas, design of anaerobic digester. Energy content of MSW, estimation of low and high heating value (LHV, HHV), theory and types of incinerators, design of incineration plant. Pyrolysis, refused derived fuel (RDF), plasma gasification: working principle, energy recovery, advantages, limitations and applications, environmental impacts of waste to energy: dioxins, furans, heavy metals etc.

Unit V: Disposal of Solid Waste (06 Hours)

Landfill: Introduction, components of land filling, types of land filling, site selection, acceptable waste, construction techniques, maintenance and precautions, leachate and landfill gas: estimation, management, treatme se, control of contamination of ground water, operation monitoring, cl advantages and disadvantages of secured landfill facility (SLF), design o ope stability analysis, concept of

bioreactor landfill: principle, types, applications. Legacy waste management or biomining: concept, methods, applications, economics and time duration.

Unit VI: Special Waste Management and Regulations (06 Hours)

Sources, collection, transportation, treatment and disposal: biomedical waste, hazardous waste, construction and demolition waste, e-waste, sanitary napkin (flow chart and one case study of each). Slaughter waste management: concept of rendering plants. Objectives and key points of hazardous and other waste management rules, 2016, construction and demolition (C&D) waste management rules - 2016, E-waste management rules - 2016, plastic waste management rules – 2016, reuse and recycling of plastic waste in road construction, case studies of processing and reuse of construction & demolition waste, material recovered from e-waste, introduction to life cycle assessment (LCA) in solid waste management.

Text Books

01 Integrated Solid Waste Management: Engineering Principles and Management Issues, George Tchobanoglous, Hilary Theisen, Samuel Vigil, Tchobanoglous George, Vigil Samuel, McGraw-Hill Companies, Incorporated.

02 Solid waste management, Dr. A.D. Bhide

03 Solid Waste Management, Sasikumar K and Sanoop Gopi Krishna, PHI.

Reference Books

01 Solid waste Engineering, Vesilind P. A., Worrell W and Reinhart, Thomson Learning Inc., Singapore.

02 CPHEEO, Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000.

03 Hazardous Waste Management, Charles A. Wentz, Second Edition, McGraw Hill International Edition, New York.

04 C for Environmental Scientists and Engineers, Y. Anjaneyulu and Valli Manickam, Wiley Publications.

05 Standard Handbook of Hazardous Waste Treatment and Disposal, Harry Freeman, McGraw-Hill Education, 1998

Savitribai Phule Pune University, Pune
B. E. Civil (2019 Pattern) w. e. f. July 2022
401 004 a Elective IV: Air Pollution and Control

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Basic concepts of sciences, mathematics

Course objectives
01 Impart the knowledge and understanding of outdoor and indoor air pollution, its impact and existing legislation and regulation.
02 Make aware about the meteorology, measurement techniques, emission inventory and modeling aspects.
03 Provide the scientific and technical background of state of the art air pollution control technologies.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Recall air pollution, legislation and regulations.
02 Evaluate air pollutant concentrations as a function of meteorology.
03 Interpret sampling results with prescribed standards.
04 Assess emission inventory and air quality models.
05 Compare the air pollution control equipments.
06 Infer indoor air pollution and its mitigation.

Course Content

Unit 1: Air Pollution, Legislations and Regulations **(06 hours)**
Air Pollution: Layers of atmosphere, Atmospheric temperature and altitude, Composition of air, Definition of air pollution, Air pollution episodes and accidents (Donora Pennsylvania 1948, Great London Smog 1952, Bhopal Gas Tragedy 1984), Classification of air pollutants (Based on sources, origin and state of matter), Criteria and hazardous air pollutants, Greenhouse gases, Sources of air pollution, Scales (micro, meso, macro), Processes and fates (Advection, convention, Diffusion, dispersion), Impact on human health and its valuation, Ozone depletion, Acid rain, Global warming, Climate change, Estimation of Carbon footprints (Numerical Included). Legislations and regulations: A case study (Air Act 1981, The Air Rules 1982, Central Motor Vehicles Act 1988, Environmental Protection Act 1986, National Environment Tribunal Act 1995, National Green Tribunal Act 2010, Draft Notice for e-Vehicles in National Capital Region 2022), Major Government Initiatives for managing ambient air quality (NAMP-National Air Quality Program, AQI-Air Quality Index (Significance, calculation method adopted by CPCB), NCAP-National Clean Air Program).

Unit 2: Meteorological Aspects **(06 hours)**
Meteorology, Meteorological parameters and measuring instruments, Wind rose diagram, Environmental lapse rate (ELR) and adiabatic lapse rate (ALR), Inversion and its types, Atmospheric stability, Pasquill-Gifford classification, Plume behaviour, Horizontal and vertical dispersion coefficients, mixing height, Determinatio using radio-soundings and remote sounding system, Stack height determinati d), CPCB recommendations, Plume rise estimation using Brigg's formula (Nu assian dispersion equation for point source; assumptions, advantages and limitat ded).

Unit 3: Ambient Air Sampling, Analysis and Standards **(06 hours)**

Ambient Air sampling and Analysis: Air pollution survey, basis and statistical considerations of sampling sites, Conversion of $\mu g/m^3$ to ppm, devices and methods used for sampling of particulates and gaseous air pollutants. Use of aerosol spectrometer and sensors, Stack emission monitoring for particulate and gaseous air pollutants, isokinetic sampling, Air Quality and Emission Standards: Components of air quality standards (Indicator, averaging time, form, level), National Ambient Air Quality Standards (NAAQS) 2009 and Emission standards in India, WHO air quality guidelines 2021, Interpretation of sampling results with case study.

Unit 4: Emission Inventory and Air Quality Modeling **(06 hours)**

Emission inventory: Definition, Role in air quality management, Utilization, Development approach (Bottom-up, Top-down), Basic equation of emission estimation, Types (Annual average, seasonal, forecasted and gridded), Emission inventory framework developed by CPCB, Air Quality Modeling: Introduction, Basic components, Importance, classification (Based on time period, pollutant type, coordinate system, level of sophistication), Types of air quality models (Physical, statistical, deterministic), AERMOD model USEPA (Assumptions, strengths and limitations).

Unit 5: Control of Air Pollution **(06 hours)**

Natural self-cleansing properties (Dispersion, gravitational settling, absorption, rainout, adsorption), Objectives, Control by process modification, change of raw materials, fuels, process equipment and process operation, Control of particulates from stationary sources: Removal Mechanism, collection efficiency, control equipment as Settling chamber, inertial separators, cyclone, fabric filter and electro Static precipitator. Scrubbers, Factors affecting selection of device (Numerical included). Control of gaseous pollutants from stationary sources: Absorption, adsorption, incineration/ combustion, carbon sequestration for CO_2, Control of emissions from mobile sources: Emission sources, Control of emissions from each source.

Unit 6: Indoor Air Pollution **(06 hours)**

Causes, sources, health impacts, factors affecting indoor air quality, sick building syndrome, General aspects of exposure assessment, Sampling design, Active and Passive samplers, monitoring of ventilation rates, Mitigating technologies: Source control, Improved ventilation, air cleaning, Types of air cleaners, Air cleaning technologies, Practical considerations using portable and in-duct air cleaners, Use of plants for control, Radon removal technique, Sources and remedial measures for odour control.

Text books

01 Air Pollution: Its origin and control, 3rd Edition, Kenneth Wark, Cecil F. Warner, Wayne T. Davis, Addison-Wesley Longman. 1998.

02 Air Pollution: Health and Environmental Impacts, Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), CRC Press, 2010

Reference books

01 Air Pollution, M. N. Rao, H. V. N. Rao, McGraw Hill, 2004.

02 Air Pollution and Control, K.V.S.G. Murali Krishna, University Science Press, 2015.

03 Fundamentals of Air Pollution, Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., Academic Press, 2005.

04 Methods of Air Sampling and Analysis RC Press, 1988.

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Savitribai Phule Pune University, Pune
B E Civil (2019 pattern) w. e. f. June 2021
401014 e: Elective VI: Green Structures and Smart Cities

Teaching scheme	Credits	Examination scheme
Lectures: 3 hours/week	03	In semester exam: 30 marks End semester exam: 70 marks

Pre-requisites
Understanding of basic civil and environmental engineering

Course objectives
01 To understand green structures and energy efficient materials and their impacts on sustainability
02 To describe different terminologies and engineering concepts involved in smart city.
03 To understand the importance of smart cities with available case studies from India.

Course outcomes
On successful completion of this course, the learner will be able to,
01 Students should be able to describe the importance of energy and minimization by altering the building materials.
02 Students should be able to understand the importance green construction and green rating system
03 Students should be able to introduce the applications of energy conservation and efficiency practices in buildings.
04 Students should be able to understand phases and approval involved in smart city project.
05 Students should be able to assess the national and global experience of smart cities.
06 Students should be able to understand the importance of sustainable development and current protocol of sustainable development goals.

Course contents

Unit 1: Introduction to Embodied Energy (06 hours)
Introduction to embodied energy, operational energy in building and life cycle energy, ecological foot print, bio-capacity and calculation of planet equivalent, introduction to civil engineering materials with embodied energy minimization concept and utilization

Unit 2: Green Construction Practices (06 hours)
Introduction to green construction practices, operational energy reduction and net zero building, introduction to optimization for design of building for energy efficiency, examples of optimization, introduction to radiation budget, surface water balance, effects of trees and microclimatic modification through greening, importance of rating and rating systems.

Unit 3: Building Integrated Photo Voltaic (06 hours)
Introduction to use of building integrated photo voltaic (BIPV) and other renewable energy in buildings their basic concepts and efficiency, introduction to energy conservation building code (ECBC-2017), mandaroty requirement for comfort system and control and electrical and renewable energy system, introduction to concepts of overall thermal transfer value (OTTV) etc.

Unit 4: Introduction to Smart Cities (06 hours)
Introduction to smart cities, introduction to ons of smart cities, phases, stages of project & their approval status, conventi components, energy demand, green

approach to meet energy demand, index of Indian cities towards smartness, introduction to statistical analysis.

Unit 5: Singular-Hybrid Smart Cities **(06 hours)**

Conventional cities, consequences, alternative resources, reliability on predictability scale, solar options, PV and thermal; singular or hybrid, global experience of smart cities, smart cities, global standards and performance benchmarks, practice codes, India "100 smart cities" policy and mission, smart city planning and development.

Unit 6: Sustainable Smart City **(06 hours)**

Swachh Bharat mission and smart cities program, financing smart cities development, smart city case studies, governance of smart cities, introduction to artificial intelligence (AI) in smart cities, introduction to (sustainable development goal) SDG, the importance of SDG 11.

Text Books

01 Green Building Materials: A Guide to Product Selection and Specification, 3rd Edition, Ross Spiegel, Dru Meadows

02 Mindful Smart Cities: Rethinking Smart Cities with Mindfulness Engineering, Shima Beigi PhD, VUB PRESS

Reference Books

01 Climate responsive architecture (A design hand book for energy efficient buildings), Arvind Krishnana, Simos Yannas, Nick Baker, S V Szokolay, McGraw hill Education, Seventh reprint.

02 Energy and the Environment, J M Fowler, McGraw Hill, New York, 2nd Edition.

03 Time-Saver Standards For Building Types, Joseph De Chiara, Michael J. Crosbie, McGraw-Hill.

04 Smart Cities: Foundations, Principles, and Applications, Houbing Song, Ravi Srinivasan, Tamim Sookoor, Wiley.

05 Beyond Smart Cities: How Cities Network, Learn and Innovate, Tim Campbell, Routledge.

IS Codes

01 Handbook on functional requirements of buildings (SP41), Bureau of Indian Standards, New Delhi, New Delhi, 1987

02 Energy Conservation Building Code (ECBC), Bureau of energy efficiency, 2017

03 Sustainable Building Design Manual- Volume I & II, TERI, 2009.

04 Green Rating for Integrated Habitat Assessment (GRIHA) guidelines

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Savitribai Phule Pune University, Pune
B E Civil (2019 pattern) w. e. f. June 2021
401014 f: Elective VI: Rural Water Supply Engineering

Teaching scheme	**Credits**	**Examination scheme**
Lectures: 03 Hours/week	03	In semester exam: 30 Marks End semester exam: 70 Marks

Pre-requisites
Understanding of basic civil and environmental engineering

Course Objectives
01 Students will gain knowledge of techno-economic issues related to Rural Water Supply.
02 Students will study interdisciplinary aspects of water supply engineering.
03 Subject will make students understand administrative aspects related to water supply.

Course Outcomes
On successful completion of this course, the learner will be able to,
01 Understand issues related to rural water supply with respect to source, water related issues in rural areas.
02 Understand role of various government departments and importance of participatory approach.
03 Understand various types of rural water supply scheme and infrastructure requirements therein.
04 Understand interdisciplinary requirements in RWS including Software
05 Understand Automation requirements for a Water Supply Project
06 Understand Documentation and O and M issues related Water Supply Project including Leak Detection.

Course Contents

Unit I: Introduction to Water Related Issues (06 hours)
Source vis-à-vis population (e.g. up to 2000 ground water, > 2000 surface), introduction to reservation of water, permissions of concerned authorities to lift water from notified river, water related issues in rural areas, water supply scheme for single gram Panchayat/Group gram Panchayat, geology/ certificate from GSDA, geology and its relation with groundwater, strengthening of source, introduction to RWH, horizontal bore, hydro-fracturing, well sinking, unconventional methods by GSDA, retrofitting of schemes. use of weep holes, yield test of open well, tube and bore well, introduction to Shivkalin Pani Sathawan Yojana, water quality and quantity.

Unit II: Socio- Economic Aspects of WS Schemes (06 hours)
Various departments involved in water conservation, participatory approach for success of project, financial scheme available with department, case studies: such as Palsoshi (Bhor), Hiware Bazar, Lamkani-(Dhule) available with MJP, capacity building of villagers.

Unit III: Various Types of Rural Water Supply Schemes (06 hours)
Introduction to single village scheme, introduction to regional rural W. S. Scheme, use of available infrastructure if any, retrofitting to available infrastructure, various components and layout of W. S. Schemes, scour depth calculation for well on bank/in a river bed, intake- Jack well (pump house), slotted pipe galleries and trench gallerie onnecting mains, recuperation test (owner's responsibility), introduction to main, introduction to WTP SR-ESR/GSR/MBR, introduction to distributio nection (Ferrule).

Unit IV: Interdisciplinary Aspects of Rural Water Supply **(06 hours)**

Introduction to electro mechanical aspects, pumping machinery, source-intake/WTP/ESR, introduction to hydraulic testing of pipelines, source: conveyance, selection of rising main and its appurtenances to control water hammer, flow, airlocks etc., introduction to pumps & pumping machinery, selection of types of pumps, calculation of hours of power required, requirements of electric supply (3 phase), availability of E. S. Software/Programmes for design of economical diameter of R. M., techno- economic comparison of various pipe materials (R. M./Gravity Main, as well as distribution lines), requirement of residual hydraulic pressure, calculation of hydraulic grade line HGL and frictional head with total head acting on pump, introduction to JALTANTRA software of IIT Bombay.

Unit V: Instrumentation in WSE **(06 hours)**

Introduction to auto pump controller, sensor for water quality monitoring cycle PH, turbidity meter, TDS meter, ultrasonic level sensor, hydraulic modeling, use of instrumentation and robotics in WSS, use of SCADA and introduction to SCADA based automation, PLC in WSE, application of GPS in WSE, application of GIS in WSE, introduction to the water meter, case study of Malakapur Town.

Unit VI: Documentation of Presentation **(06 hours)**

Record drawings of executed works, (As built drawings), periodical maintenance of pumping machinery, electrical components and other machinery, training requirements to villagers on operation and maintenance issues, introduction to preventive maintenance, leakage detection: techniques used and importance.

Text Books

01 Water Supply Engineering, S. K. Garg, Khanna Publications

02 Water Supply Engineering, Dr. P. N. Modi, Standard Book House

Reference Books

01 CPHEEO Manual on Water Supply and Treatment

02 Rural Water Supply And Sanitation by Sanjay Gupta

03 IWWA Technical Data Book (Available with IWWA Pune Local Centre)

04 Special Reference Material Recommended:
Compendium of Training Materials for the Capacity Building of the Faculty and Students of Engineering Colleges on Under the Unnat Maharashtra Abhiyan (UMA) Prepared By Institute for Resource Analysis and Policy, Hyderabad & CTARA, IIT Bombay Supported by UNICEF, Mumbai March, 2018

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Audit Course 5:

Disaster Management

311087

The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

Course Contents:

1. Different Types of Disaster: Natural and man made
2. Risk and Vulnerability Analysis
3. Disaster Preparedness
4. Disaster Response
5. Reconstruction and Rehabilitation as a Means of Development.
6. Damage Assessment
7. Post Disaster effects and Remedial Measures.
8. Long-term Counter Disaster Planning

Audit Course 5:

Industrial Waste management

311087

Introduction: Characteristics of industrial wastes, Types of industries and industrial pollution, Population equivalent, Bioassay studies, effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health, Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.

Waste management Approaches: Waste Audit, Volume and strength reduction, Material and process modifications, Recycle, reuse and byproduct recovery – Applications.

Treatment technologies: Equalization, Neutralization, Removal of suspended and dissolved organic solids, Chemical oxidation, Adsorption, Removal of dissolved inorganics, combined treatment of industrial and municipal wastes, Residue management, Dewatering, Disposal

References:

1. Zander Elis,, Industrial Waste Management, Larsen and Keller Education, 2017, ISBN: 9781635491494
2. John P. Samuelson, Industrial Waste: Environmental Impact, Disposal and Treatment, Nova Science Publishers, 2009, ISBN: 9781606927205

Audit Course 6
Energy Auditing and Management in Industries

311094

Course outcomes:

- Understand the basic concepts of energy audit and energy management
- Explain different types of energy audit, maximizing and optimizing system efficiency.
- Summarize energy management systems, prepare and present energy audit report
- Identify energy saving potential of thermal and electrical systems
- Discuss Energy audit instruments, Procedures and Techniques.

Energy Auditing: Concepts, Need of Energy audit, Types of energy audit, Energy management (audit) approach, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Energy audit instruments, Procedures and Techniques.

Energy Management: Design of Energy Management Programmes, Development of energy management systems, Importance, Industrial need of Energy Management, Preparation and presentation of energy audit reports, Monitoring and targeting, some case study and potential energy savings.

Text Books:

1. Murphy, W. R., Energy Management, Elsevier, 2007.
2. Smith, C. B., Energy Management Principles, Pergamum, 2007
3. Sonal Desai, Handbook of Energy Audit, , McGraw Hill Education Private Ltd.,

Reference Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. W.C. Turner, Energy Management Handbook, John Wiley and Sons.
4. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publication, Washington, 1988
5. Elias P. Gyftopoulos, Industrial Energy Conservation Manuals, MIT Press, Mass, 1982

BE (Chemical Engineering)-2019 Course
Code: 409345
Elective IV
Credits: 3
409345: (C) Green Technology

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 hr / week	In Semester : 30
	End Semesters : 70
	Total: 100

Unit 1: Principles and concepts of Green Chemistry: (6 Hrs)
Introduction, Sustainable Development and Green Chemistry, Atom Economy, Atom Economic Reactions, Rearrangement Reactions, Addition Reactions, Atom Un-economic Reactions, Substitution Reactions, Elimination Reactions, Wittig Reactions, Reducing Toxicity, Measuring Toxicity

Unit 2: Production, Problems and Prevention: (7 Hrs)
Introduction, Some Problems Caused by Waste, Sources of Waste from the Chemical Industry, The Cost of Waste, Waste Minimization Techniques, The Team Approach to Waste Minimization, Process Design for Waste Minimization, Minimizing Waste from Existing Processes, On-site Waste Treatment, Physical Treatment, Chemical Treatment, Bio-treatment Plants, Design for Degradation, Degradation and Surfactants, DDT, Polymers, Some Rules for Degradation, Polymer Recycling, Separation and Sorting, Incineration, Mechanical Recycling, Chemical Recycling to Monomers

Unit 3: Measuring and controlling environmental performance: (7 Hrs)
The Importance of Measurement, Lactic Acid Production, Safer Gasoline, Introduction to Life Cycle Assessment, Green Process Metrics, Environmental Management Systems, The European Eco-management and Audit Scheme, Eco-labels, Legislation, Integrated Pollution Prevention and Control. Catalysis and green chemistry: Introduction to Catalysis, Comparison of Catalyst Types, Heterogeneous Catalysts, Basics of Heterogeneous Catalysis, Zeolites and the Bulk Chemical Industry, Heterogeneous Catalysis in the Fine Chemical and Pharmaceutical Industries, Catalytic Converters, Homogeneous Catalysis, Transition Metal Catalysts with Phosphine Ligands, Greener Lewis Acids, Asymmetric Catalysis, Phase Transfer Catalysis, Hazard Reduction, C–C Bond Formation, Oxidation Using Hydrogen Peroxide, Bio-catalysis, Photocatalysis.

Unit 4: Organic solvents, Environmentally benign solutions: (7 Hrs)
Organic Solvents and Volatile Organic Compounds, Solvent-free Systems, Supercritical Fluids, Supercritical Carbon Dioxide, Supercritical Water, Water as a Reaction Solvent, Water-based Coatings, Ionic Liquids, Ionic Liquids as Catalysts, Ionic Liquids as Solvents, Fluorous Biphase Solvents. Renewable resources: Biomass as a Renewable Resource, Energy, Fossil Fuels, Energy from Biomass, Solar Power, Other Forms of Renewable Energy, Fuel Cells, Chemicals from Renewable Feedstock's, Chemicals from Fatty Acids, Polymers from Renewable Resources, Some Other Chemicals from Natural Resources, Alternative Economies, The Syngas Economy, The Biorefinery, Chemicals from renewable feed stocks.

Unit 5: Emerging Greener technologies ergy solutions: (6 Hrs)
Design for Energy Efficiency, Photochem ıntages of and Challenges Faced by Photochemical, Processes, Examples of P ons, Chemistry Using Microwaves, Microwave Heating, Microwave-assisted emistry, Sonochemistry and Green

Chemistry, Electrochemical Synthesis, Examples of Electrochemical Synthesis. Designing greener processes: Conventional Reactors, Batch Reactors, Continuous Reactors, Inherently Safer Design, Minimization, Simplification, Substitution, Moderation, Limitation, Process Intensification, Some PI Equipment, Examples of Intensified Processes, In-process Monitoring, Near-infrared Spectroscopy

Unit 6: Industrial case studies: **(7 Hrs)**

A Brighter Shade of Green, Greening of Acetic Acid Manufacture, EPDM Rubbers, Vitamin C, Leather Manufacture, Tanning, Fatliquoring, Dyeing to be Green, Some Manufacturing and Products Improvements, Dye Application, Polyethene, Radical Process, Ziegler–Natta Catalysis, Metallocene Catalysis, Eco-friendly Pesticides, Insecticides. An integrated approach to a greener chemical industry: Society and Sustainability, Barriers and Drivers, The Role of Legislation, EU White Paper on Chemicals Policy, Green Chemical Supply Strategies

Text Books:

1. Mike Lancaster, Green Chemistry, Royal Society of Chemistry, 2010.
2. Paul T. Anastas John C. Warner, Green Chemistry: Theory and Practice, Oxford University Press, 2000.
3. Jay Warmke, Annie Warmke, Green Technology, Educational Technologies Group, 2009.

E-Resources: NPTEL/SWAYAM

4.	**Demonstration of Drilling machine** Demonstration on construction of Radial drilling machine, Tool holding devices, Concept of speed, feed and depth of cut.
5.	**Demonstration on Milling machine** Demonstration on construction, table movements, indexing and tooling of milling machine.
6.	**Demonstration of Shaper/Grinding machine (Any one)** Shaper: Crank and slotted link mechanism, Work feed mechanism Grinding: Surface grinder/Cylindrical grinding machine, Mounting of grinding wheel
7.	**Term work includes one job of Carpentry** Introduction to wood working, kinds of woods, hand tools & machines, Types of joints, wood turning. Pattern making, types of patterns and its allowances.
8.	**Term work to include one job involving fitting** to size, male-female fitting with drilling and tapping operation on Mild Steel plate; Introduction to marking, cutting and sawing, sizing of metal, shearing, Concept of fits and interchangeability, selection of datum and measurements.
9.	**Term work to include one utility job preferably using sheet metal** (e.g. Tray, Funnel etc.) with riveting/welding/brazing/soldering (at least one temporary and one Permanent joint either using resistance welding/Arc welding); Introduction to sheet metal operations: punching, blanking, bending, drawing.
10.	**Prepare a Layout of Workshop** To prepare a work shop layout.
11.	**Collection of information about safety norms** in any one of the following type of industry:Metalworking/Chemical/Cement/Pharmaceuticals/Defense/Atomic energy/Aerospace /Marine/Construction/Railway etc.

Reference/Text Books

1. John, K. C., (2010),"Mechanical Workshop Practice, Prentice Hall Publication, New Delhi
2. Hazra and Chaudhary, Workshop Technology-I & II, Media promoters & Publisher Pvt. Ltd.

TH:02 Hrs./week — **101007: Environmental Studies-I (Mandatory Non-Credit Course)**

Course Objectives:

1. To explain the concepts and strategies related to sustainable development and various components of environment.
2. To examine biotic and abiotic factors within an ecosystem, to identify food chains, webs, as well as energy flow and relationships.
3. To identify and analyze various conservation methods and their effectiveness in relation to renewable and nonrenewable natural resources.
4. To gain an understanding of the value of biodiversity and current efforts to conserve biodiversity on national and local scale.

Course Outcomes: On completion of the course, learner will be able to–

CO1:Demonstrate an integrative approach to environmental issues with a focus on sustainability.

CO2: Explain and identify the role of the organism in energy transfers in different ecosystems.

CO3: Distinguish between and provide examples of renewable and nonrenewable resources & analyze personal consumption of resources.

CO4: Identify key threats to biodiversity and develop appropriate policy options for conserving biodiversity in different settings.

Course Contents

Unit I **Introduction to environmental studies** **(02 Hrs)**

Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere. Scope and importance; Concept of sustainability and sustainable development.

Unit II **Ecosystems** **(06 Hrs)**

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems:

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit III **Natural Resources: Renewable and Non-renewable Resources** **(08 Hrs)**

Land Resources and land use change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods droughts, conflicts over water (international & inter-state).

Heating of earth and circulation of air; air mass formation and precipitation.

Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit IV **Biodiversity and Conservation** **(08 Hrs)**

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity; In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Suggested Readings:

1. Carson, R. 2002. Silent spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. Principals of Conservation Biology.
   Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339:36-37.
7. McCully, P.1996. Rivers no more: the environmental effects of dams (pp.29-64). Zed Books.
8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

107008 – Engineering Mathematics – II

Teaching Scheme:	**Credits**	**Examination Scheme:**
TH : 4 Hrs./Week	**05**	**In-Semester : 30 Marks**
TUT : 1 Hr./Week		**End-Semester : 70 Marks**
		TW : 25 Marks

Prerequisites:

Integration, Differential Equation, Three-dimensional coordinate systems

Evaluation and Continuous Assessment:

It is recommended that the all activities are to be record and regularly, regular assessment of work to be done and proper documents are to be maintained at college end by both students as well as mentor (you may call it PBL work book).

Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department and institutes.

Recommended parameters for assessment, evaluation and weightage:

- Idea Inception **(5%)**
- Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product **(50%)** (Individual assessment and team assessment)
- Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents) **(25%)**
- Demonstration (Presentation, User Interface, Usability etc) **(10%)**
- Contest Participation/ publication **(5%)**
- Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects **(5%)**

PBL workbook will serve the purpose and facilitate the job of students, mentorand project coordinator. This workbook will reflect accountability, punctuality, technical writing ability and work flow of the work undertaken.

References:

- Project-Based Learning, Edutopia, March 14, 2016.
- What is PBL? Buck Institute for Education.
- www.schoology.com
- www.wikipedia.org
- www.howstuffworks.com

101014: Environmental Studies-II

TH: 02 Hr/week **Mandatory Non-Credit Course**

Course Objectives:

1. To provide a comprehensive overview of environmental pollution and the science and technology associated with the monitoring and control.
2. To understand the evolution of environmental policies and laws.
3. To explain the concepts behind the interrelations between environment and the development.
4. To examine a range of environmental issues in the field, and relate these to scientific theory.

Course Outcomes: On completion of the course, learner will be able to–

CO1: Have an understanding of environmental pollution and the science behind those problems and potential solutions.

CO2: Have knowledge of various acts and laws and will be able to identify the industries that are violating these rules.

CO3: Assess the impact of ever increasing human population on the biosphere: social, economic issues and role of humans in conservation of natural resources.

CO4: Learn skills required to research and analyze environmental issues scientifically and learn how to use those skills in applied situations such as careers that may involve environmental problems and/or issues.

Course Contents

Unit V **Environmental Pollution** **(08 Hrs)**

Environmental pollution : types, causes, effects and controls; Air, water, soil, chemical and noise pollution

Nuclear hazards and human health risks

Solid waste management: Control measures of urban and industrial waste

Pollution case studies.

Unit VI **Environmental Pollution** **(07 Hrs)**

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities& agriculture.Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto Protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context

Unit VII **Human Communities and the Environment** **(06 Hrs)**

Human population and growth; Impacts on environment, human health and welfares.

Carbon foot-print. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods earthquakes, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.

Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit VIII **Field work** **(05 Hrs)**

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river Delhi Ridge, etc

Suggested Readings:

1. Carson, R. 2002. Silent spring. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P.H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. Principals of Conservation Biology, Sunderland: Sinauer Associates, 2006
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339:36-37.
7. McCully, P.1996. Rivers no more: the environmental effects of dams (pp.29-64). Zed Books.
8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.