Semester - I

ENERGY, ECOLOGY AND ENVIRONMENT			
Course Code	22ESE12	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits:04		Exam Hours	03

Course objectives: This course introduces students to environment concerns. Students are expected to learn about environment, factors affecting it, environmental ethics and its protection through lectures, presentations, documentaries and field visits.

MODULE-1	
Interrelation between energy, ecology and environment. Sun as a source of energy, nature of its radiations. Interrelationship between energy and environment, Sun as a source of energy, nature of its radiation, Biological processes, photosynthesis, Autecology and Synecology.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation,Reliable Videos

MODULE-2	
Population, Community Ecosystem (wetland, terrestrial, marine). Population, Community Ecosystem (wetland, terrestrial, marine) Food chains, Ecosystem theories.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

MODULE-3	
Sources of energy, Classification of energy sources. Environmental issues related to harnessing to fossil fuels (coal, oil, natural gas), geothermal, tidal, nuclear energy, solar, wind, hydropower, biomass	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

MODULE-4	
Energy flow and nutrient cycling in ecosystem and environmental, Degradation. Air and water pollution.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

MODULE 5	
Environmental issues related to harnessing to fossil fuels (coal, oil, natural gas), geothermal, tidal, nuclear energy, solar, wind, hydropower, biomass, Energy flow and nutrient cycling in ecosystems	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Brief description of module-wise activities pertaining to self-learning component

Sl.NO	Experiments
1	Solar: Experimental study on thermal performance of solar water heater, solar dryers, solar cooker; solar PV module characterization with different configuration
2	Biomass: Experimental study on thermal performance and efficiency of biomass downdraft Gasifier and sampling and analysis of air and flue gas from biomass energy systems i.e. Gasifier, combustor and cook stoves using gas chromatography technique;
3	Liquid bio-fuel production and characterization; Biogas production by anaerobic digestion and analysis.
4	Fuel: Density, Viscosity, Flash-point, Fire-point Pour-point, ASTM distillation of liquid fuels;
5	Proximate and Ultimate analysis, calorific value of solid fuels
6	Instrumentation and control: Use of microprocessor kit, microcontroller, data acquisition and display experiments, performance evaluation of renewable energy systems (solar thermal,

	solar PV, Wind turbine, biomass Gasifier) using microprocessor/microcontroller based data acquisition systems
11	Can be Demo experiments for CIE
12	Can be Demo experiments for CIE

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However,

in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

1. G. M. Masters, W. P. Ela, Introduction to Environmental Engineering and Science, Prentice Hall, 2007.
2. D. Nevers, Air Pollution Control Engineering, McGraw Hill, 2001.
3. A. Mackenzie, A. S. Ball, S. Virdee, Instant Notes: Ecology, BIOS Scientific Publishers Ltd., 2001.
4. F. Armstrong, K. Blunde, Energy Beyond oil, Oxford University Press, 2007.
5. G. T. Miller, Spoolman S., Environmental Science, Yolanda Cossio, 2010.
6. J. L. Chapman, W. J. Reiss, Ecology Principles and Applications, Cambridge University Press,2008.

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc19_ge23/preview
2. https://nptel.ac.in/courses/127105018
3. https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-ge23/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Semester- I

Fuel Technology

Course Code	PCC 22ESE13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	

Course Learning objectives:
To introduce history, importance and components of chemical engineering, concepts of unit operations and unit processes, and current scenario of chemical & allied process industries.

Module-1

Principles of Combustion , Solid, liquid and gaseous fuels , Coal as a Source of Energy and Chemicals in India

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-2

Coal as a Source of Energy and Chemicals in India , Coal Preparation, Carbonization

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-3

Carbonization, Gasification Liquefaction of coal and lignite Petroleum, properties and its derived products.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-4

Inter-conversion of fuels, Gaseous fuels including natural gas and uses, Combustion of solid, liquid and gaseous fuels.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-5

Types of combustion, Combustion appliances for solid, liquid and gaseous fuels,
Introduction to nuclear fuels, RDF, Bio-fuels, etc.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:

Books

1. J. G. Speight, Chemistry and Technology of Coal, CRC Press, 2012.
2. J. G. Speight, Chemistry and Technology of Petrolium, CRC Press, 2012.
3. D. M. Indra, Petroleum Refining technolgy, CBS Publishers and disytributors, 2015.
4. S. Sarkar, Fuels and Combustion, Orient Longman, 2009.
5. F. Peter, Fuels and Fuel Technology, Wheatan & Co. Ltd., 2002

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/103105110
https://archive.nptel.ac.in/content/syllabus_pdf/103105110.pdf
https://archive.nptel.ac.in/courses/112/106/112106299/

Skill Development Activities Suggested

Semester- I

Electrical Energy Management

Course Code	PCC 22ESE14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: Evaluate sustainable energy management practices,
Develop systems for comprehensive energy audits. Evaluate cleaner energy sources, technologies and management practices, Institute energy conservation programs, Integrate energy sources with applicable technologies and management practices

Module-1

INTRODUCTION: Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting- energy audit process.

Teaching-Learning	Chalk & Talk, Power Point Presentation, Reliable Videos

Process	
Module-2	
ENERGY COST AND LOAD MANAGEMENT : Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures- cost of electricity-Loss evaluation- Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos
Module-3	
ENERGY MANAGEMENT FOR MOTORS & ELECTRICAL EQUIPMENT : Systems and equipment-Electric motors-Transformers and reactors-Capacitors and synchronous machines	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos
Module-4	
METERING FOR ENERGYMANAGEMENT: Relationships between parameters-Units of measure-Typical cost factors- Utility meters - Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters - Metering location vs. requirements- Metering techniques and practical examples	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos
Module-5	
LIGHTING SYSTEMS: Concept of lighting systems - The task and the working space -Light sources - Ballasts - Luminaries - Lighting controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques-Lighting and energy standards	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Text Books :

1. Reay D.A, Industrial Energy Conservation, first edition, Pergamon Press, 1977.
2. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
3. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2003.

References :

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Guide to Energy Management, Fifth Edition, The Fairmont Press, Inc., 2006
2. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific & Technical, ISBN-0-582-03184, 1990.
3. Capehart B.L., Turner W.C., Kennedy W.J. (2011). Guide to Energy Management (7th Edition). Fairmont Press. ISBN: 1439883483.
4. Patrick D.R., Fardo S.W., Richardson R.E., Fardo B.W. (2014). Energy Conservation Guidebook (3rd Edition). Fairmont Press. ISBN: 1482255693.
5. Kreith F., Goswami D.Y. (2007). Energy Management and Conservation Handbook. CRC Press. ISBN: 9781420044294.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=agSEQaVMkDE
https://www.youtube.com/watch?v=6vOg-u7c1IE
https://www.youtube.com/watch?v=uy9lZCdkQIM
https://www.youtube.com/watch?v=8Aqc44PG4Ws

Skill Development Activities Suggested

Semester- I

POWER GENERATION, TRANSMISSION AND DISTRIBUTION			
Course Code	**22ESE15**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	

Course Learning objectives:

To enable the students to understand the economic aspects of power generation, analyse the performance of transmission lines, distribution systems, insulators and cables.

Module-1

Synchronous generator operation, Power angle characteristics and the infinite bus concept, dynamic analysis, Modeling of synchronous machines, Excitations systems,

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-2

Prime mover governing systems, Automatic generation control, Power system stabilizer, Artificial intelligent controls, Power quality

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-3

Overhead and cables, Transmission line equations, Regulation and transmission line losses, Reactive power compensation, Flexible AC Transmission. HVDC converters, advantages and economic considerations

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-4

converter control characteristics, analysis of HVDC link performance, Multi-terminal DC system, HVDC and FACTS, Distribution systems, conductor size, Kelvin's, analysis of HVDC link performance, Multi-terminal DC system, HVDC and FACTS.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Module-5

Distribution systems, conductor size, Kelvin's law, performance calculations and analysis, Distribution inside and commercial buildings entrance terminology, Substation and feeder circuit design considerations, distribution automation, Futuristic power generation

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Reliable Videos

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. ALLEN. J. Wood and B. F. Wollenberg, Power Generation, Operation, and Control. John Wiley & Sons, 2003.
2. P. M. Anderson and A. A. Fouad, Power System Control and Stability, Wiley-IEEE Press, 2002.
3. O. I. Elgerad, Electric Energy Systems Theory: An Introduction, T M H Edition, 1982..
4. C. K. Kim, V. K. Sood, G. S. Jang, J. Lim, J. Lee, HVDC Transmission: Power Conversions
5. Applications in Power Systems, Wiley – IEEE Press, 2009.
6. T. Gonen, Electric Power Transmission System Engineering Analysis and Design, CRC Press, 2009.
7. P. Kundur, Power system stability and control, McGraw-Hill, 1994.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/108/102/108102047/ https://nptel.ac.in/courses/108102047 https://nptel.ac.in/courses/108105104 https://kanchiuniv.ac.in/academics/department-of-electrical-and-electronics-engineering/nptel-videos/
Skill Development Activities Suggested

Research Methodology and IPR			
Course Code	**22RMI16**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	**3:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**3**	Exam Hours	03

Course Learning objectives:

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Module-1	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation, NPTEL ,VTU E-learning resources , Experimental learning, Problem based learning

Module-2	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation, NPTEL ,VTU E-learning resources , Experimental learning, Problem based learning

Module-3	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation, NPTEL ,VTU E-learning resources , Experimental learning, Problem based learning

Module-4

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation, NPTEL ,VTU E-learning resources , Experimental learning, Problem based learning

Module-5

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation, NPTEL ,VTU E-learning resources , Experimental learning, Problem based learning

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1) Three Unit Tests each of **20 Marks**
2) Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1) The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

Suggested Learning Resources:

Text Books

Reference Books:

Web links and Video Lectures (e-Resources):

Skill Development Activities Suggested:

1) Interact with industry (small, medium, and large).
2) Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3) Involve in case studies and field visits/ fieldwork.
4) to the use of standards/codes etc., to narrow the gap between academia and industry.
5) Handle advanced instruments to enhance technical talent.
6) Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7) Accustom Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem.	L1, L2
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	L1, L2
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	L1, L2
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports.	L1, L2, L3
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.	L1, L2, L3, L4

Energy Laboratory

Course Code	22ESEL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	01:02:00	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

The aim of Energy Laboratory II is to ground the analytical subject material in a practical problem, meaning that the skills and knowledge students learn throughout the programme will be applied in real renewable energy engineering work.

Sl.NO	Experiments
1	Study of Characteristics of Francis Turbine
2	Characterization of solid fuel (Proximate Analysis)
3	Determination of calorific value of solid fuel
4	Performance study of heat pump system & Thermoelectric Generator and Refrigerator
5	To study the performance and emission characteristics of a spark ignition engine for ethanol/butanol-gasoline blend.
6	Fractional distillation of Petroleum
7	Performance of Solar Still & I-V Characteristics a Solar Cell 3, Performance of Photo-voltaic Thermal titles 3, Photovoltaic-Roof Top on Synergy Building
8	To study the performance and emission characteristics of a diesel engine for biodiesel-diesel blend

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

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Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination (SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute; examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

Semester-II

Water and Waste Water: Pollution and Control Technologies			
Course Code	22ESE21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50

Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	

Course Learning objectives: Systems designed to remove waterborne wastes from communities, industries, and so on while protecting the health of people and the environment. (1) to collect wastewater from residences, industries, institutions, and so on, (2) to find a place to discharge the wastewater (usually the nearest water course is chosen, but wastewater could also be used for groundwater recharge or even recycled to water supply), (3) to remove water pollutants that would produce adverse impacts to the receiving water or adversely affect the health of people subsequently using the water and (4) to do all the above in a cost - effective manner.

Module-1	
Fundamentals: Definition, Classification, Sources Water quality Standards. Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants. Surface Water Treatment: Water Purification, Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) and Its Application, Response of Stream to Bio-Degradable Organic Wastes.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2	
Water Treatment Methods: Principles and Design, Aeration Systems, types of settling and settling equations, design criteria and design of settling tanks. Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-3	
Unit processes, Water Softening- Principles and design- Ions causing hardness, various methods. Waste Water Treatment: Principles and Design, Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis. Mass Loading Factors, Impacts, Estimation and Their Unit Loading.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4	
Principle of Biological Treatment; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency. Theoretical principles and design : Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Aerobic Attached Growth, Trickling Filters,	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5	
Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants. Sludge Processing: separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Numerical problems and Case Studies	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of 20 Marks
2. Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-

Suggested Learning Resources:

Books

1. Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.
2. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGrawHill International Publication IIIrd Edition.1986
3. Environmental Engineering - Howard S. Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986
4. Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.
5. Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. NewDelhi 2nd
6. Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw HillPublication New Delhi 3rd Edition.
7. Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.
8. Energy Conservation in water and wastewater facilities.Water Treatment Handbook, Vol. 1& 2
9. Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development,GOI, New Delhi, 1999

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/105107207
https://nptel.ac.in/courses/105106119
https://onlinecourses.nptel.ac.in/noc21_ce25/preview
https://onlinecourses.nptel.ac.in/noc19_ce32/preview
https://nptel.ac.in/courses/105104102
https://nptel.ac.in/courses/103107084

Skill Development Activities Suggested

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Semester - II

New & Renewable Energy, Sources And Technologies			
Course Code	22ESE22	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	03:02:00	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits:04	04	Exam Hours	03

Course objectives:
To introduce concepts of solar energy conversion and the various ways of storing the solar energy
To understand the principles of wind energy conversion devices, types of wind turbines and Generators.
To study about Geothermal energy, ocean energy, wave energy, tidal energy, fuel cell, hydrogen energy, biomass and its conversion technologies

MODULE-1

Energy Scenario World Energy Scenario Use and their availability and overall energy demand. Energy Consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Sustainable Development, Role of Renewable Energy sources in Sustainable development, Energy Consumption and its impact on environmental climatic change. Indian Energy Scenario: Commercial and non-commercial forms of energy, Fossil fuels, Renewable sources including Bio-fuels in India, their utilization pattern in the past, present and future projections of consumption pattern, Sector wise energy consumption.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

MODULE-2

Wind potential in India and world, basic principle of wind energy Conservation characteristics of wind power, Extractable wind power, Site selection, wind data analysis and predictions, Use of statistical tools, Different types of Wind Machines Electricity generating standalone systems & grid connected systems, Performance Estimation of Wind turbines, Aerodynamic construction of rotor blades, Wind Farms, wind mills & their

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

MODULE-3

Small Scale Hydroelectric (Mini & Micro Hydel): Classification of Small Hydro Power Stations, Components of a Hydroelectric Scheme, Civil Works Design Considerations for Mini and Micro Hydel Projects, Turbines and Generators for Small Scale Hydro Electric, Protection, Control and Management of Equipment, Advantages and Limitations of Small Scale Hydro-Electric, Hybrid Systems, Hydrolic Ram and its Applications

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

MODULE-4

Geothermal Energy Potential Sites, Estimations of Geothermal Power, Nature of Geothermal Sites, Hot-Dry Rocks Resources, Magma Resources, Systems for Energy Generation, Applications of Geothermal Energy, Environmental Issues. Ocean Energy: Basic Theory of OTEC, Potential and application of Technologies, Basic Theory of Wave Energy, Potential and Technologies, Basic Theory of Tidal Energy, Potential and Technologies.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

MODULE 5

Direct Energy Conversion FUEL CELLS: Basic Principle of working, potential, classification of Fuel Cells, Types of Fuels cells, Advantages & Disadvantages, Conversion efficiency of fuel cells, Types of Electrodes, Applications, Thermo – Electric Generators and Refrigeration. HYDROGEN ENERGY Production, Electrolysis, Thermo-chemical methods, Fossil fuel methods, Solar Energy Methods, Storage, Transportation, Applications.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Solar PV systems
2	Analysis of effect of dust and temperature on Solar PV Module
3	Effect of shading on solar panels
4	Performance testing of PV system with tracking

5	Effect of tilt angle on solar PV system
6	Effect of bypass diode and blocking diode for a solar PV panel
7	Solar thermal systems: Testing of solar flat plate collectors thermo syphonic flow and forced flow
8	Performance testing of solar thermal concentrators
9	Performance testing of solar thermal concentrators with oil for heat transfer
10	Performance testing of solar cooker
11	Can be Demo experiments for CIE.: Analysis of grid synchronized solar PV system
12	Can be Demo experiments for CIE. : Solar simulator experiment

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test at the end /after completion of all the experiments shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in

the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

1. Twidell & AW. Wier, Renewable energy resources, English Language book, Society I E & FN Spon (1986).
2. Grey & O.K. Ganhus, Tidal power, Plenum Press, New York (1972).
3. Goswami. Alternative energy in agriculture, Vol. II CRC Press Inc. Florida, 1986.
4. E.R. Berman, Geothermal Energy; 'Noyes DATA Corporation, New Jersey, 1975.
5. D.A Stafford. & D.L. Hawkee & R Horton, CRC Press Inc., Florida.
6. N.K. Bansal., M. Kleeman & M. Mielee, Renewable conversion technology, Tata McGrawHill, New Delhi.
7. S.S.L. Chang, energy Conversion, Prentice Hall Inc., 1963
8. V.D., Hunt, Wind power: A handbook on Wind energy Conversion systems. Van Nostrand Reinhold Company, 1981.
9. D.A. Stafford, D.A, Hawkees, D.L. & R. Hoston, Methane production from waste organic matter, CRC Press, Boca Raton, 1980

Web links and Video Lectures (e-Resources):

1. TERI Energy Data Year Books.
2. Planning commission statistics
3. www.bp.com/centres/energy
4. www.eia.doe.gov
5. www.epa.org
6. Bureau of Energy Efficiency- Volume 1

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Semester- II-----Professional Electives-1

ENERGY POLICIES FOR SUSTAINABLE DEVELOPMENT			
Course Code	22ESE231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives:

Frame issues from a public policy energy and sustainability perspective ♣ Create a matrix of cross-sectoral issues and linkages ♣ Assessment of unintended outcomes and risks ♣ Assessment of Policy implementation challenges ♣ Have an understanding of path dependencies

Module-1

Energy policies of India - Supply focus approach and its limitations - Energy paradigms - DEFENDUS approach - End use orientation - Energy policies and development

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2

Case studies on the effect of Central and State policies on the consumption and wastage of energy - Critical analysis - Need for renewable energy policies in India. Energy and environment – Green-house effect - Global warming - Global scenario - Indian environmental degradation

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-3

Environmental laws - Water (prevention & control of pollution) act 1974 - The environmental protection act 1986 - Effluent standards and ambient air quality standards - Latest development in climate change policies & CDM

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4

Energy conservation schemes - Statutory requirements of energy audit - Economic aspects of energy audit - Capital investments in energy saving equipment - Tax rebates - Advantages of 100% depreciation – India's plan for a domestic energy cap & trade scheme.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5

Social cost benefit analysis - Computation of IRR and ERR - Advance models in energy planning - Dynamic programming models in integrated energy planning - Energy planning case studies - Development of energy management systems - Decision support systems for energy planning and energy policy simulation.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:

Books

J. Goldemberg, T.B. Johansson, A.K.N. Reddy and R.H. Williams: *Energy for a Sustainable World*, Wiley Eastern, 1990
2. IEEE Bronze Book: *Energy Auditing*, IEEE Publications, 1996
3. P. Chandra: *Financial Management Theory and Practice*, Tata McGraw Hill, 1992
4. *Annual Energy Planning Reports of CMIE*, Govt. of India
5. A.K.N. Reddy and A.S. Bhalla: *The Technological Transformation of Rural Inda*, UN Publications, 1997
6. A.K.N. Reddy, R.H. Williams and J.B. Johanson: *Energy After Rio-Prospects and Challenges*, UN Publications, 1997
7. P. Meier and M. Munasinghe: *Energy Policy Analysis & Modeling,* Cambridge University Press, 1993

8. R.S. Pindyck and D.L. Rubinfeld*: Economic Models and Energy Forecasts*, 4e, McGraw Hill, 1998

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc20_hs68/preview
https://onlinecourses.nptel.ac.in/noc21_mg94/preview
https://onlinecourses.nptel.ac.in/noc21_de07/preview
https://nptel.ac.in/courses/124106157
https://onlinecourses.nptel.ac.in/noc22_hs126/preview

Skill Development Activities Suggested

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Semester- II

Energy Conservation by Waste Heat Recovery

Course Code	22ESE232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives:
Waste heat recovery is so important because by reducing the amount of fuel used to produce heat in a boiler installation, heating efficiency increases, resulting in lower fuel use. This serves both the requirement to increase efficiency and reduce carbon emissions

Module-1

Introduction: heat losses, its quality and quantity, potential for energy conservation. Waste heat sources: steam, compressed air, refrigeration, flue gases, furnace/air stream exhaust, high grade heat, low grade heat.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2

Optimal utilization of fossil fuels, Total energy approach; Coupled cycles and combined plants; Cogeneration systems. Exergy analysis; Utilization of industrial waste heat; Properties of exhaust gas; Gas-to- gas, gas-to-liquid heat recovery systems;

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-3

Recuperators and regenerators; Shell and tube heat exchangers; Spiral tube and plate heat exchangers Waste heat boilers: various types and design aspects. Heat pipes: theory and applications in waste heat recovery.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4

Prime movers: sources and uses of waste heat; Fluidized bed heat recovery systems; Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems; Thermoelectric system to recover waste heat; Heat pump for energy recovery; Heat recovery from incineration plants .

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5

Waste Heat Recovery calculations: Quantifying available heat (kWh), Pinch analysis, typical energy costs/construction costs, pay back analysis, Thermo- economic viability. Need for energy storage: Thermal, electrical, magnetic and chemical storage systems.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:Books

1. Hewitt, G. F., Shires, G. L., and Bott, T. R. (1993); Process Heat Transfer, CRC Press, Florida.
2. Li K. W. and Priddy A. P. (1985); Power Plant System Design, John Wiley
3. Goswami, D. Y., and Kreith, F. (2007); Energy Conversion, CRC Press.
4. Harlock J. H. (1987); Combined Heat and Power, Pergaman Press
5. Kreith F. and West R. E. (1999); Handbook of Energy Efficiency, CRC Press
6. Kays W. M. and London A. L. (1984); Compact Heat Exchangers, Third Edition, McGraw-Hill
7. Jensen J. (1980); Energy Storage, Newnes - Butterworths.

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc20_mm20/preview
https://nptel.ac.in/courses/112105221
https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-mm23/

Skill Development Activities Suggested

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Cogeneration and Energy Efficiency

Course Code	22ESE233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: Primary objective of the course is to introduce students the basis of the Energy Analysis which is an emerging area in the field of energy science and engineering. Emphasis will be placed on developing theoretical basis along with numerical examples for understanding the exergetic evaluation of thermal energy systems, components, devices and thermal power plants and refrigeration/

Heat pump/ Air conditioning Plants. The course is mainly planned for BTech/ M.Tech students in thermal engineering and energy studies. The students need to have basic background of thermal science and thermodynamics. Students other than thermal science background should consult the instructors before registering this course.

Module-1	
Introduction The concept of cogeneration, main design parameters for cogeneration, cogeneration Alternatives, bottoming and topping cycles, Cogeneration potentials.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-2	
Steam turbine plants, Gas turbine plant, Diesel and gas engine plants, Thermodynamic evaluation, combined cycle applications, Sterling engine.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-3	
Industrial Cogeneration Industry / utility cogeneration, Tri generation, Techno economic and Environ-mental aspects.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-4	
Economic & Environmental Aspects Environmental evaluation, cost allocation methods,	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-5	
Sizing & operating cogeneration systems, Case Studies Cogeneration in sugar, textile, paper and steel industry	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course**.**

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Energy Cogeneration Hand Book for Central Plant Design by George Polimeros.

1. Power Plant Technology by M.M.EI- Wakil

Web links and Video Lectures (e-Resources):

http://knowledgeplatform.in/wp-content/uploads/2017/03/2.7-Cogeneration-.pdf.
https://freevideolectures.com/course/4166/nptel-steam-power-engineering/11
https://alison.com/course/sustainable-architecture-energy-efficiency-and-quality?utm_source=google&utm_medium=cpc&utm_campaign.

Skill Development Activities Suggested

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1		
CO2		
CO3		

Program Outcome of this course

Sl. No.	Description	POs

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										
CO2										
CO3										
CO4										
CO5										

Semester- II

AIR AND NOISE POLLUTION: EFFECTS AND CONTROL TECHNOLOGIES			
Course Code	**22ESE234**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: Demonstrate the concept of participates, air pollutants, natural and artificial methods of ventilation; the concept of noise pollution ELO3 CLO2 Calculate the units for participates and air pollution treatment G2 CLO3 Analyse the effect of air pollution, noise pollution

Module-1

Noise Pollution and Control

The Decibel Scale, Sound Intensity Level. Classification of Noise, Noise Standards. Effects of Noise, Noise Control Methods, Acoustical Materials, Acoustical Enclosures, Silencers and Muffle Reverberation Control, Personal Hearing Protection Devices, Role of Vegetation in Noise Control.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2

Air Pollution & Control: Definition, Air Quality, Classification of Air Pollutants, Air Pollution Episodes.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-3	
Air Pollution Monitoring Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SOx,NOx, CO, Oxidants and Ozone.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-4	
Meteorology & Dispersion of pollutants: Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths. Air pollution control technologies for particulates and gaseous contaminants. Gravity settlers, Electrostatic precipitators, bag Filters Scrubbers Cyclone, control for moving sources	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-5	
Global Concerns, Light Pollution and Thermal Pollution	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Understanding Environmental Pollution Marquita K.
2. Environmental Pollution And Its Control, COGENT International, 1st edition 1998 S.A.Abbasi
3. Environmental Noise Pollution And Its Control, Anmol Publication 1st edition 1992 Chhatwal G.R.et al
4. Environmental Pollution And Its Control Jeffrey J. and P.A. Vesilind
5. Air Pollution: M. N. Rao & HVN Rao, TATA McGraw Hill Publication, New Delhi, 12th edition, 1998
6. Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986
7. Environmental Engineering - Howard S.Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986.
8. T K Ray, Air Pollution Control in Industries , Vol-1,2
9. J.N.B, Air Pollution and Plant Life.

10. Robert Jennings Heinson, Air Pollution.

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc22_ce22/preview
https://nptel.ac.in/courses/105102089
https://nptel.ac.in/courses/103107084
https://nptel.ac.in/courses/105107213

Skill Development Activities Suggested

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Semester- II

Engineering Thermodynamics, Heat Transfer and Process Integration

Course Code	22ESE235	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: To improve the efficiency of a process for the transformation between energy and work. To study energy conversion in different forms. To study the entropy of a system. Estate definition of system, surrounding, closed and open system, extensive and intensive properties. Calculate absolute and gage pressure, and absolute temperature. calculate changes in kinetic, potential, enthalpy and internal energy.

Module-1

Basic Heat Transfer Concept and Terminology:
Basic Concepts Terminology, Heat Transfer Coefficients, Thermal Resistance, Overall Heat Transfer Coefficient.

Conduction: Conduction Equation, Steady State Conduction in simple geometries, Thermal; Contact Resistance Critical Thickness of Insulation, Multidimensional Steady State Heat Conduction (Shaper Factor), Types of Fins, Effectiveness and Efficiencies of Fins Area Weighted Fine Efficiency, Transient Heat Conduction ,Lumped Heat Capacity Analysis, Heiler's Charts for Semi-Infinite Medium, Slab Cylinder and Sphere, Periodic Heat Conductions.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2

Convection: Similarity Principle, Mass moments and Energy Balance equations, Evaluation of Dimensionless Parameters, Forced Flow Convection (Laminar, Turbulent &Mixed) Thermal and Velocity Boundary Layer Thickness Convective Heat Transfer Coefficient ,Drag Coefficient for Flat Plate, Inside tube , Cylinder, Sphere and banks of tubes, Free convection (Laminar, Turbulent &Mixed) on horizontal Verticals and Inclined Plates, Inclined Parallel Plates, Horizontal, Verticals, Cylinder and

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-3	
Radiation: Blackbody Radiation, View Factor Algebra, Enclosures with Black Surfaces and Grey Surfaces, Radiosity, Heat Exchangers and its Types, Effectiveness, LMTD and NTU Methods.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4	
Pinch Technology and Process Integration Principle of pinch Technology , Stream Network, Design of Energy Recovery System, Selection of Pinch Temperature Difference: Graphical and Tabular Methods, Stream Splitting, Process Retrofit Application, Installation of heat pump and engines, Grand Composite Curves.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5	
Engineering Thermodynamics: Quantity and Quality Aspects, Properties of Pure Substances: Ideal gas, Equation of State and corresponding state correlations for PVT Systems, Fundamental Concepts and basic Principles. **The First Law of Thermodynamics:** Fundamentals, Closed Systems, first Low Analysis of Control Volumes, Steady Flow Process, Steady Flow Engineering Devices, Reversible Work, Irreversibility energy, Exergy **Second Law Efficiency of Thermodynamics:** Fundamentals, Carnot Cycle, Availability Analysis of Closed Systems, Analysis of Steady Flow Systems, and Analysis of unsteady Flow Systems. **Sterling Engine:** Principle, working and efficiency. **Thermodynamics of Flow Process:** Nozzle, Throttling of Gases and Vapours, Mixing of gases, Compressors. **Chemical Thermodynamics:** Chemical Reactions, Chemical and Phase Equilibrium, Thermodynamics Analysis of Process	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. M.N. Oziesik, Heat Transfer - A Basic Approach, McGrew Hill Book Co., New Delhi.
2. M. Becter, Heat Transfer: A Modem Approach
3. S.P. Shukatme, Heat Transfer, Orient Longman, New Delhi.

4. W.H. Giedt, Principles of Engineering Heat Transfer, D.Van Norstand Company Inc.(1961)
5. F. Kireth, Radiation Heat Transfer, International Text book Co., Semton, USA (1962).
   - Process Integration, Chapter of Energy Efficiency, By Eastop. Bejan Adrian – Heat Transfer
   - Y. Bayazitoglu – Element of Heat Transfer Karlekar – Heat Transfer J.P. Holman – Heat Transfer
   - Robin Smith -- Chemical Process (Design and Integration)

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/103107094
https://archive.nptel.ac.in/content/syllabus_pdf/103107094.pdf
https://www.digimat.in/nptel/courses/video/103101137/L42.html
https://www.digimat.in/nptel/courses/video/103103144/L12.html
https://www.digimat.in/nptel/courses/video/103107093/L01.html

Skill Development Activities Suggested

Semester- II----Professional Electives-2

Instrumentation and Control in Energy Systems

Course Code	22ESE241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives:

The basic objective of Instrumentation and control is to operate the thermal power station efficiently. Economically, safely, reliably, continuously, and qualitatively. The course focuses on imparting the principles of measurement which includes the working mechanism of various sensors and devices, that are in use to measure the important physical variables of various mechatronic systems.

Module-1

Overview of Instruments and Measurement Systems Principles of measurements and Measurement errors, Classification of instruments, static and dynamic characteristics, Input Output configurations of measurement system.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2

Types, characteristics and applications of Mechanical transducers, Types, characteristics and applications of electrical transducers, Principles of Modern sensors and typical applications. instruments for measuring temperature, pressure, velocity and flow, heat flux, liquid level and concentration in energy systems, characterization of combustors, flue gas analyzer, exhaust gas

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-3

Solar energy measurement requirements and instruments, meteorological data measurements, energy auditing instruments, energy audit kit, humidity measurements, Introduction to Control Systems: Overview of control systems, types and components, Feedback and non-feedback systems and their applications

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4

Transfer function, block diagram, Representation and reduction techniques, Signal conditioning: Operational amplifier types and characteristics, Application circuits- inverter, adder, subs tractor, multiplier and divider, Analog /digital/analog conversion techniques.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5

Microcontrollers and compilers: Overview of microprocessor and microcontroller, Microcontroller Types and architecture, Use of compilers for data acquisition, processing and display, typical microcontroller Applications for monitoring and control of electrical and non–electrical parameters/processes.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation,Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:

Books

1. Morris A. S. (1998); Principles of Measurements and Instrumentation, Prentice Hall of India
2. Sawhney A. K. (2011); A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai
3. Bentley J. P. (2005); PrinciplesofMeasurement Systems, Fourth Edition, Pearson Prentice Hall
4. Jain R. P. (1998); Modern Digital Electronics, McGraw Hill.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/108105064
https://nptel.ac.in/courses/108105063
https://nptel.ac.in/courses/108105088
https://onlinecourses.nptel.ac.in/noc22_me59/preview
https://onlinecourses.nptel.ac.in/noc22_de09/preview

Semester- II

Solar Refrigeration and Air Conditioning			
Course Code	22ESE242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: To understand the concept of refrigeration • To acquire knowledge of methods of refrigeration • To acquire knowledge of Air refrigeration system • To acquire knowledge of vapour compression and vapour absorption refrigeration system. • To acquire knowledge of refrigerants

Module-1

Introduction Basics of refrigeration and air conditioning, comfort zones, potential and scope of solar cooling and heating, fundamentals of conventional vapor compression system and vapour absorption system. Solar cooling technology: solar electrical cooling, solar thermal cooling:- open cycles (liquid and solid desiccant system), closed cycle (absorption cycle, adsorption cycle, solar radiation cooling), thermo mechanical systems, steam ejector cycle, solar combined power/cooling.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-2	
Desiccant Air Conditioning Desiccant materials, classification of desiccant material, fundamentals of desiccant material: adsorption process, regeneration process, adsorption rate, regeneration rate, factor affecting adsorption and regeneration of desiccant material, heating/humidification, cooling/dehumidification, and desiccant dehumidifiers: desiccant bed, desiccant wheel, desiccant coated heat exchanger, solar powered desiccant air conditioning system.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-3	
Adsorption Refrigeration System Introduction, principle of adsorption, thermodynamics of adsorption cycles: - basic adsorption cycle, heat recovery adsorption refrigeration cycle, mass recovery adsorption refrigeration cycle, thermal wave cycle, convective thermal wave cycle, intermittent adsorption systems: silica-gel/water and silica-gel methanol systems, zeolite–water systems, activated carbon–methanol systems, activated carbon–ammonia systems.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-4	
Absorption Refrigeration System Absorption cycle of operation, maximum, COP, properties of solution, aqua-ammonia solution, simple absorption system, h-x diagram, ammonia enrichment process and water -lithium bromide refrigeration system, single-effect solar absorption cycle, half-effect solar absorption cooling system, double-effect solar-assisted absorption cooling systems, diffusion absorption solar cooling system, hybrid solar absorption cooling systems.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-5	
Solar Air-conditioning and Economics Refrigerant storage for solar absorption cooling systems. Solar thermoelectric refrigeration and air conditioning. Economics of solar cooling.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. Arora C. P Refrigeration and Air conditioning-Tata McGraw Hill, 2004
2. Stanley W Angrist Direct Energy conversions, Allyn& Bacon, 1982

Web links and Video Lectures (e-Resources):

1. https://onlinecourses.nptel.ac.in/noc22_me135/preview
2. https://nptel.ac.in/courses/112105128
3. https://onlinecourses.nptel.ac.in/noc19_me58/preview
4. https://elearn.nptel.ac.in/shop/nptel/refrigeration-and-air-conditioning/

Skill Development Activities Suggested

Semester- II

Energy Modeling & Project Management			
Course Code	22ESE243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: Students will understand: The different types of energy models and their applications; How energy modeling can help optimize facilities and enhance the performance of facilities; The advantages and disadvantages for some of the popular energy modeling tools in use today; and How energy models have been used to optimize facility performance. Assumes responsibility as a professional practitioner of project management, applying PM principles and practices while maintaining high standards of practice, making ethical judgments and decisions in a respectful, and sustaining professional standing through a commitment to life-long learning

Module-1

Introduction: Role of modeling and project management in energy project	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-2	
Energy Markets: Monopoly, oligopoly and competitive markets, behavior of markets with price change of energy, balance payment problems. **Basic Pricing:** Basic Pricing Principles, Growing Demands and Dynamic effects, Short Run versus Long Run Marginal Cost Pricing, Peak load and seasonal pricing, Pricing of Non-renewable energy resources. Subsidized Prices and life line rates	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-3	
Energy Planning: Planning and Role of Demand Management, Integrated National Energy Plan, Supply and Demand analysis, Energy action planning, Energy Balance, Perfect competitive economy, economic second best considerations, life line rates for poor consumers, Decentralized Energy Planning, Energy Modeling, Date Analysis & Demand management, LP models, Case studies, Force Field Analysis, Energy Policy Purpose, Perspective, Contents, Formulations and Ratification.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation,Videos from reliable sources
Module-4	
General Management: Organizing, Location of Energy Management, Top Management Support, Managerial Functions, Roles and Responsibilities of Energy Manager, Accountability, Motivating – Motivation of Employees. **Financial Management:** Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs, and Case Studies. Concept and purpose of projects management, functions of project manager, project feasibility analysis, project appraisal criteria, monitoring and control of a project,	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources
Module-5	
Project Management: Definition and scope of project, Technical Design, Financing, Contracting, Implementation and Performance Monitoring, Implementation Plan for top management, Planning Budget, Procurement procedures, Construction, Measurement and Verification. Investment needs Appraisal and Criteria, Financial Methods of Projects evaluations, Case Studies. **Network Analysis:** PERT and CPM network	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

Suggested Learning Resources:

Books

1. D. Deo, S. Modak and P. R. Shukla, Decentralized Energy Planning Oxford and IBH Publishing Co. Pvt. Ltd.,
2. B. Bukhootaeo et al. Energy, Planning and Policy
3. J.K. Parikh,Modeling Approach to long term de and Energy Implications.
4. Markdias, Forecasting Methodologies.
5. Koontz,O.Donnel and We@ich,Managewnt Kogakuj3ha.Tokyo.
6. R.D. Agrawal, Organization and Management, Tata McGrew Hill, New Delhi.
7. Newman and Warren, The Process of Management, Concepts, Behavior and Practice, Prentice Hall of India, Mm Delhi.

Web links and Video Lectures (e-Resources):

TERI Energy Data Year Books.
Manual on Industrial Energy Audit, Energy Management Centre
https://onlinecourses.nptel.ac.in/noc19_mg30/preview
https://nptel.ac.in/courses
https://onlinecourses.nptel.ac.in/noc22_mg71/preview
https://www.classcentral.com/institution/nptel

Skill Development Activities Suggested

Semester- II

Bio and Solid Waste Management			
Course Code	22ESE244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Learning objectives: Upon successful completion of this course, students will be able to: Learn basic concepts of solid waste management, beginning from source generation to waste disposal in a system of municipality organizational structure.• Develop understanding on various technological applications for processing of waste and their disposals in various ways.• Acquire knowledge on waste to energy productions in the perspectives of sustainable development.• Apply basic concepts in hazardous waste management and integrated waste management for urban areas.• To acquire a fair amount of knowledge on waste characterization and its management practiced in various cities of India. To achieve this objective, students will be taught different case studies reported by previous researchers and technical bodies.To protect the risk of spreading diseases. To protect the health and well-being of health care workers and the community. To protect against injury and potentially fatal infection. To provide environment-friendly waste management solutions. To promote the quality and sustainability of the environment.
Module-1
Biomass & Biomass management Biomass availability, Characteristics of biomass or organic wastes, Energy Plantation, Waste Biomass/Organic utilization Technology options, Potential, Process and technologies, characteristics of Briquettes and their use.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2
Biochemical Process Aerobic and Anaerobic Bioconversion process, Biogas production process, Effect of feed and Operational parameters, Types of digesters and their suitability, Applications. Design criterion of some Bio-methanation Plants, optimum sizing of landfill digesters & gas storage systems.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-3
Thermo chemical Process Biomass Gasification Process, Types of Gasifiers and their working, Feed and operational parameters on output gas production, properties of output gases (mainly producer gas), Design of a Gasifier. Biomass Pyrolysis: Process of slow and fast Pyrolysis for solid and liquid fuel Production, Technologies, Applications.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4
Bio-oils and Composting Characteristics of Bio-diesel, Materials and Methods, and its applications, Alcoholic Fermentation Process, Technologies and its applications. **Composting:** Process Material and operational, Parameters, characteristics of manure, applications. Vermi-composting: Process, Types of Species, Materials and Methods, Characteristics of Manure, Applications.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5
Characterization of Different Types of Solid Waste, Municipal Solid Waste, Agro Waste, Others. **Hazardous Waste:** Characterization, Collection, Transportation, Treatment, Storage and Disposal. **Waste Management:** Different Option, Integrated Waste Management Strategies, Collection, Transportation and Environmental Impact.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:

Books

1. Biomass – Thermo-chemical Characteristics Edited by PVR Iyer; T R Rao; P D Grover and N P Singh, Published by Biomass gasifier Action Research Centre, Dept of Chemical Engineering , IIT Delhi
2. Kaup and Goss (1984) "Small Scale Gas Producer Engine System" Published by Friedr, Vieweg & Sohn Braunschweig/ Wiesbaden.
3. ABETS, IISc, Bangalore (2003) "Biomass to Energy – The science and technology of the IISc Bio-energy systems" Published by Science & Technology of the Indian Institute of Science, Bangalore
4. Reed, T. B. and Das, A. (1988) "Hand book of biomass down draft gasifier engine systems". Published by Solar Energy Research Institute, U.S. Dept. of Energy K M Mital ,Biogas System - Principles & Applications Published by new Age international (p) Ltd, New delhi
5. Klaus von Mitzlaff, "Engines for biogas- theory, modification & economic operation" Published by friedr. Vieweg & Sohn Braunschweig/ Wiesbaden
6. Orion Polinsky "A Bio-fuels Handbook" Published by Oasis Publishing 2002.

Web links and Video Lectures (e-Resources):

https://swayam.gov.in/courses
https://nptel.ac.in/courses/105103205
https://onlinecourses.nptel.ac.in/noc22_ce82/preview
https://archive.nptel.ac.in/courses/105/103/105103205/
https://www.digimat.in/nptel/courses/video/105103205/L01.html

Skill Development Activities Suggested

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Semester- II

ALTERNATIVE FUELS FOR TRANSPORTATION			
Course Code	**22ESE245**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: This course helps satisfy the following objectives: 1. Develop professional fundamentals 2. Understand energy infrastructure 3. Comprehend traditional, alternative, and sustainable energy production technologies. Work with alternative fuels. 5. Prepare for an alternative fuelled economy. 6. Assess societal, economic, environmental, ethical, and legal impacts of alternative fuel systems.

Module-1

An introduction to hydrocarbon fuels - their availability and effect on Environment. Gasoline and Diesel self ignition characteristics of the fuel, octane number, cetane number.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-2

Alternative fuels - Liquid and Gaseous Fuels. Physico-chemical characteristics. Alternative Liquid Fuels. Alcohol fuels - Ethanol & Methanol. Fuel composition, Fuel Induction techniques, fumigation, emission of oxygenates, applications to engines and automotive conversions

Teaching-Learning Process	Chalk & Talk, Power Point Presentation Videos from reliable sources

Module-3

Biodiesel formulation techniques, trans esterification, application in diesel engines. CME (Dimethyl ether), properties Fuel injection consideration

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-4

General introduction to LPG and LNG. Compressed Natural Gas components, mixtures and kits, fuel supply system and emission studies and control. Hydrogen combustion characteristics, flashback control techniques, safety aspects and system development, NOx emission control.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Module-5

Biogas, Producer gas and their characteristics, System development for engine application.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos from reliable sources

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:Books **Alternative Fuels for Transportation (Mechanical and Aerospace Engineering Series) Hardcover – 13 October 2010** by Arumugam S. Ramadhas CRC Press; 1st edition (13 October 2010) Alternative Fuels for Transportation *Edited By A S Ramadhas*, ISBN 9781439819579, Published November 16, 2010 by CRC Press, 463 Pages 187 B/W Illustrations Alternative Fuels for Transportation, https://library.oapen.org/handle/20.500.12657/41650, **Publisher** Taylor & Francis **Publisher website,** https://taylorandfrancis.com/, **Publication date and place** 2011,**Imprint,**CRC Press Alternative Transportation Fuels **A.S. Ramadhas,** CRC Press; April 2016, ISBN: 9781439819586, Edition: 1, CRC Press
Web links and Video Lectures (e-Resources):
https://nptel.ac.in/courses/108105058 https://library.oapen.org/bitstream/20.500.12657/41650/1/9781439819586.pdf https://nptel.ac.in/courses/103102022.
Skill Development Activities Suggested •

Laboratory

RENEWABLE ENERGY LABORATORY			
Course Code	**22ESEL26**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**1:2:0**	SEE Marks	50
Credits	**02**	Exam Hours	03

Course objectives: The aim of Renewable Energy Laboratory is to ground the analytical subject material in a practical problem, meaning that the skills and knowledge students learn throughout the programme will be applied in real energy engineering work.

Sl.NO	Experiments
1	Solar Radiation Data Monitoring and Analysis: Sunshine hour duration, Direct Solar Radiation, Global Solar Radiation, Diffuse Solar Radiation
2	Solar Photovoltaic: Current-voltage characteristics of Solar Cell, Efficiency Variation of solar cell, Performance variation of solar photo cell at different light intensities,;
3	Determination of power produced by a solar photo voltaic system, Performance Evaluation of a Solar Photo voltaic lighting system and its components: inverter, charge controller and battery, Performance evaluation of a solar photovoltaic water pump.
4	Fuel Properties and analysis: Proximate and ultimate analysis, Calorific value of solid fuels, Density, Viscosity, Flash-point, Fire-point Pour-point, Distillation of liquid fuels,
5	Fuel properties determination: Cloud and pour (melt) point, Viscosity, Calorific value, Sulfur percentage, Flash point, relative density of fuel, Iodine value of bio-fuel, Ash percentage of fuel.
6	Solar thermal measurements and analysis: Experimental study of thermal performance of Solar water heater, Evacuated tube solar collector, Solar still.
7	Thermal performance of solar drying system, Thermal testing of a box type Solar Cooker, Concentrator type and community solar cookers, Designing and testing of Innovative solar thermal systems
8	Introduction to Engineering Equation Solver software.
	Demonstration Experiments (For CIE) Study Experiments on Energy Systems from the Following List:
9	Heat Exchanger , Refrigeration Systems and heat pumps

10	Air-conditioning Coils , Heat pipes
11	Wind Energy System
12	Fluidized Bed System , Waste Heat Recovery Systems

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- .

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination (SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

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Semester- III

Semester- III

OPERATION OF ELECTRICAL ENERGY SYSTEMS WITH LARGE SCALE INTEGRATION OF RENEWABLE ENERGY SOURCES.			
Course Code	**22ESE31**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	04	Exam Hours	
Course Learning objectives: Provide examples of common types of renewable and non-renewable resources. Understand and explain general ways to save energy at a personal, community and global level. Understand and explain, in general terms, how passive solar heating, hydropower and wind power work.			
Module-1			
General structure of Indian power system, roles of various organizations like RLDCs, SLDCs, REMCs, ISO, CERC, SERC, GENCO, TRANSCO, DISCOs, RESCOs, in power supply chain. Challenges with large scale Integration of RE sources, Scheduling practices followed in Indian/International scenarios.			
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials		
Module-2			
Power flow analysis for a) transmission and b) unbalanced distribution networks with solar photovoltaic and wind integration system: observe the effect of integration of these resources Power flow analysis , State estimation , Security and stability analysis of integrated energy systems			
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials		
Module-3			
Optimal operation dispatch (with economic dispatch as special case), and unit commitment with solar photovoltaic and wind integration system Strategies for demand side management, demand response, participation of Electric Vehicles in DSM, Load shaping with demand side management, demonstration of DSM and Demand Response (DR) at distribution/building load time of demand (TOD) management			
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials		
Module-4			
Market mechanisms to buy/sell power in a deregulated environment, Balancing, congestion management. take three problems from existing topics and will solve it by making their own programming modules			
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials		
Module-5			
Ancillary services (reserve types: battery, pumped storage, inertia) , Smart Grids/Micro Grid Operations			
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials		

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:

Books

1. Lawrence E. J., Renewable Energy Integration, Practical Management of Variability,Uncertainty, and Flexibility in Power Grids, Elsevier Publications(2016).
2. Kirschen G. S., Fundamentals of Power System Economics, WILEY (2014).
3. John J. G., William D. S., Power System Analysis, McGraw Hill (2003).
4. Peer reviewed journals such as IEEE Transaction on Power System, IEEE Transaction on Smart
5. Grid, IET Generation Transmission Distribution, IET Renewable Power Generation.
6. SastryS.S., Introductory Methods of Numerical Analysis, Prentice Hall (2005)

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/103103206
2. https://archive.nptel.ac.in/courses/108/107/108107113/
3. https://archive.nptel.ac.in/courses/121/106/121106014/
4. https://www.vssut.ac.in/lecture_notes/lecture1428910296.pdf
5. https://www.irena.orgf/-/media/Files/IRENA/Agency/Publication/2019/Feb/IRENA_Innovation_Landscape_2019_report.pd

Skill Development Activities Suggested /self-learning component

1. Basics and modelling of various power system components,
2. Numerical Analysis Methods NR, FDLF, Least square estimation
3. Optimality conditions, basics of optimization theory,
4. Load frequency control (single area/multi area): controlled/uncontrolled cases, Automatic Voltage Control

Semester- III----Professional Electives-3

Energy Auditing			
Course Code	22ESE321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: After successful completion of this course, students shall be able to; 1. Understand and learn the basic knowledge of Energy Auditing, Energy Standards And Different Govt. Schemes for Energy Saving 2. Learn different techniques for Energy Auditing according to requirements i.e. Residential, Commercial, Industrials 3. Learn the working of different Instruments/Devices used for Energy Auditing 4. Learn about Planning of Energy Audit according to time

Module-1	
Global energy auditing scenario and overview, Need for energy auditing, Difference between energy auditing and energy management.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-2	
Basic concepts in energy auditing, Energy auditing methodology, Measurement techniques, Mass and energy balances	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-3	
Energy auditing in buildings (HVAC and lighting systems), Energy auditing in power plant, Evaluation of energy conservation opportunities.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-4	
Environmental concepts and concerns, Elements measurements, Impact assessment, Guidelines and legislations.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-5	
Energy monitoring, Presentation of report, Case studies and Laboratory work.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:Books

1. L.C.Witte, P.S.Schmidt, D.R.Brown , Industrial Energy Management and Utilisation, Hemisphere Publ, Washington,1988.
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
3. I.G.C.Dryden, Butterworths, The Efficient Use of Energy, London, 1982
4. W.C.Turner, Wiley, Energy Management Handbook, New York, 1982

Web links and Video Lectures (e-Resources):
https://nptel.ac.in/courses/112105221 https://nptel.ac.in/courses/108105058 https://onlinecourses.nptel.ac.in/noc20_mm20/preview https://nptel.ac.in/courses/109106161
Skill Development Activities Suggested

Semester- IIi

ENERGY STORAGE			
Course Code	**22ESE322**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: The aim of the course is for the students to acquire knowledge on energy storage technologies, the evaluation of different storage methods and the calculation of basic storage systems connected to RES, so that they perform according to the provisions.
Summarize the basic components of a battery and the fundamental principles governing its operation Explain the materials used in modern lithium-ion batteries and their respective operational characteristics Discuss the factors that control battery performance and the primary mechanisms responsible for performance degradation. Describe advanced energy storage devices such as super-capacitors and metal-air batteries

Module-1	
Significance and types of Energy Storage , Sensible Thermal Energy Storage , Latent Energy Storage	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-2	
Thermal Management System design using Latent Thermal Energy, Storage, Assessment of Thermal Energy System, a) Evaluation of thermo-physical properties of storage materials, b) Distinction between energy and exergy ,c) Energy and exergy in performance assessment of systems, d) Exergy	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-3	
Optimization of Thermal Energy Systems, Thermochemical heat storage system, thermal energy storage system for heating and hot water in residential buildings a) Hydrogen energy storage b) Hydrogen based fuel cell c) Solar hydrogen production.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-4	
Battery Electrical Energy Storage Systems: a) Types of batteries & electrical behaviour b) Influence in interconnected systems.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-5	
Pumped storage systems: configuration, operation, Other electrical energy storage system e.g. Flywheel, super-capacitors, etc. Integration of energy storage systems with distributed generation, systems and electric grid.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:

Books

1. Khalilpour, K.R., Anthony Vassallo, A., Community Energy Networks with Storage-Modeling
2. Frameworks for Distributed Generation, Springer, 2016.
3. Cabeza, L.F., Advances in Thermal Energy Storage Systems: Methods and Applications, Woodhead Publishing, UK, 2015.
4. Kalaiselvam, S., Parameshwaram, R., Thermal Energy Storage for Sustainability-Systems, Design, Assessment and Applications, Academic Press Inc., 2014.

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc21_mm34/preview
https://archive.nptel.ac.in/courses/113/105/113105102/
https://www.digimat.in/nptel/courses/video/113105102/L58.html
https://www.youtube.com/watch?v=no4vRKvKxcU
https://www.classcentral.com/course/swayam-electrochemical-energy-storage-43586

Skill Development Activities Suggested

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Semester- III

Distributed and Decentralized Energy Systems			
Course Code	22ESE323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: About current technological and social solutions and trends in energy production and distribution - About interconnectedness of technological, social, cultural and political developments - About main social drivers of technological innovations - Analysing future trends from broad SSH perspective - Identifying possible SSH impacts of technological innovations - Understanding complex socio-technical relations of macro and micro level energy systems - team work - applying group strategic analysis methods.

Module-1

Operation of Distributed Generation Sources: roof top photovoltaic systems, wind, small hydro systems, biomass/biogas based generation sources, Operation and control of inverters for distributed energy resources	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-2	
Stand-alone operation of renewable distributed energy resources, Unbalanced Distribution power flow, State estimation, Harmonic power flow.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-3	
operational aspects of distribution system with multiple DERs and energy storage devices, Multi generation frequency control	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-4	
Voltage/reactive power management in integrated systems , Distribution system reconfiguration, Role of ICT in integration of Distributed energy sources	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials
Module-5	
Operation and Control of Rural/Urban/Industrial Micro Grids, Discussions regarding actual case studies from the field.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:Books

1. Toshihisa F., Integration of distributed resources in power systems, Academic Press (2016).
2. Salvador A., Modelling Distributed Energy Resources in Energy Service Networks, IET Press, Renewable Energy Sources (2013).
3. Jhangir H., Pota H. R., Robust control of grid voltage stability: high penetration of renewable energy: Interfacing conventional and renewable power generation resources, Springer (2014).
4. Peer reviewed journals such as IEEE Transaction on Smart Grid, IET Renewable Power Generation.
5. Sastry S.S., Introductory Methods of Numerical Analysis, Prentice Hall, 2005
6. Elgerd O.I., Electrical Energy Systems Theory: An Introduction, Indian Edition (Reprint), 2017

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/109106161
https://www.youtube.com/watch?v=ptiaNGkuylY
https://mnit.ac.in/cee/downloads/Syllabus/UG/UG_open_electives_CEE2020.pdf
https://www.unescap.org/sites/default/files/14.%20FS-Decentralized-energy-system.pdf

Skill Development Activities Suggested

1. Basics and modelling of various electrical components,
2. Numerical Analysis Methods NR, Least square estimation
3. Basics of Load frequency control (single area/multi area): controlled/uncontrolled cases
4. Automatic Voltage Control

Semester- III

ENERGY EFFICIENT BUILDINGS			
Course Code	22ESE324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: The main objective of the course is to introduce students to the fundamentals of energy efficiency in buildings. This is accomplished by applying theory to practice, drawing on experience across the world to prepare students to apply what they have learned.: The course covers technical, legal, financial and practical aspects of energy efficiency in buildings with the goals of: • providing participants with a vision of the "big picture", • providing enough details to engage productively on any of the topics, and • providing resources for information and collaboration

Module-1

Climates and buildings: Climatic zones in India and their characteristics, Implications of climate on building design – human comfort conditions in building indoors, Urban climate and Micro climate

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-2

Energy Conscious buildings: Building envelope, site, form and orientation, building components - internal and external shading devices, need for proper ventilation

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-3

Passive cooling and heating concepts for various climate zones in India advantages and disadvantages, **Air Conditioning-** Estimation of heat loads – Air conditioning load calculation - Brief concept only, Chilled water system, Energy conservation techniques in air conditioning systems

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-4

Lighting Design: Lighting Design Principles, Quantity and Quality determination method of interior lighting design – general design considerations only. Daylight – Artificial light integration Solid State Lighting: Basics of solid state lamps – white light generation techniques – Power LEDs – LED driver considerations

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Module-5

Introduction to lighting control – lighting control strategies – Energy Management strategies – Switching Control – sensor technology –Applications. Digital lighting control based system – lighting Automation – DMX, DALI. **Green buildings:** Specialities and benefits, target areas of a Green building design –BEE in building energy conservation in India - ECBC -Green building rating systems such as LEED and GRIHA – brief overview
only.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video Tutorials

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:

Books

1. Handbook of Energy Conscious Buildings, J. K. Nayak, J. A. Prajapathi, Ministry of Non-conventional Energy Sources, Government of India, 2006.
2. IES Lighting Handbook, 10th Edition IESNA, 2011.
3. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press, 1986.
4. Energy Management Guide Books, Revision – II, Bureau of Energy Efficiency, India.
5. A.K Mittal, Electrical and Mechanical Services in High Rise Buildings – Design and Estimation Manual , CBS Publishers and Distributors Pvt. Ltd, New Delhi, 2014.
6. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling for Buildings – Design for Efficiency, II Edition, McGraw Hill, 2009.

Web links and Video Lectures (e-Resources):

https://www.unescap.org/sites/default/files/14.%20FS-Decentralized-energy-system.pdf
https://archive.nptel.ac.in/courses/106/106/106106169/
https://nptel.ac.in/courses/115105127

Skill Development Activities Suggested

Semester- III

SMART GRID TECHNOLOGIES			
Course Code	**22ESE325**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: This course provides knowledge about Smart electric power grids, including definition, design criteria, technology and IoT. Information processing and communications to the power grid. Understanding the development of the smart grid, Smart grid design, implementation, evaluation and management of smart electricity infrastructure.

Module-1

Introduction Early smart grid initiatives, overview of the technologies required for the smart grid, information security for the smart grid.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video

Module-2
Smart Grid Introduction to grid connectivity of RE systems, smart grid and emerging technologies, operating principles and models of smart gird components, key technologies for generation, networks, loads and their control capabilities; decision-making tools.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video

Module-3
Smart Metering Introduction, evolution of electricity metering, key components of smart metering, overview of the hardware used for smart meters, smart metering protocols.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video

Module-4
Distribution Management Systems Structure and main components of a distribution management system, SCADA, distribution system modeling, new trends for smart grids, topology analysis, power flow analysis

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video

Module-5
WAMPAC System : System design of WAMPAC systems, Wide Area Monitoring and State Estimation, Real-time Diagnostics and Situational Awareness, Smart Grid Planning Issue, Diagnostics, Self-Healing and Reliability of Smart Grids, Demand Response Management through Smart Grid Technology, System Identification Technologies with PMUs.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Video

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub question covering all the topics under a module.

Suggested Learning Resources:Books

1. Nick Jenkins, JanakaEkanayake, [et al.] *Smart Grid Technology And Applications*, Wiley India Ltd.
2. Ali Keyhani, Muhammad Marwali, *Smart Power Grids 2011*, Springer-Verlag Berlin Heidelberg 2012.
3. Ali Keyhani, *Design of Smart Power Grid Renewable Energy Systems,* Wiley-IEEE Press 2016

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/108107113 https://onlinecourses.nptel.ac.in/noc21_ee68/preview https://archive.nptel.ac.in/courses/108/107/108107113/ https://www.digimat.in/nptel/courses/video/108107113/L01.html https://www.classcentral.com/course/swayam-introduction-to-smart-grid-14165
Skill Development Activities Suggested

Semester- III----Professional Elective-4

Battery Management Systems			
Course Code	22ESE331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: This course empowers learners to: • Explain the exact need for a BMS in a battery-supported application and list the set of functions a BMS should support. • Interpret the BMS specifications in light of the basic functionalities. • List the most important BMS components, their requirements, and their value for the system. • Explain the concept of State of Health and State of Charge. • Evaluate if a string of battery cells is balanced and what the impact is of imbalance.

Module-1

Introduction to Battery Technology: Introduction to battery terminologies, Working of a cell, Li-ion cells, Equivalent-Circuit Models: Open-circuit voltage (OCV), State-of-charge dependence, Equivalent series resistance, Diffusion voltages, Warburg impedance, Hysteresis voltages, Enhanced self-correcting cell model, Battery testing - Lab tests to determine OCV relationship, Lab tests to determine dynamic relationship.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-2

Battery Management System Design Requirements: Purposes of a battery-management system, Battery-pack sensing of Voltage, Temperature and Current, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Charger control, Communication via CAN bus, Log book function, State of charge estimation, Energy estimation, Power estimation, SOH estimation.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-3

Battery State of Charge Estimation: Definition of State of Charge, SOC estimation: Voltage-based methods to estimate SOC, Current-based method to estimate SOC, Model-based SOC estimation, SOC estimation using Linear Kalman Filter.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-4

Battery State of Health Estimation: Effect of ageing on Total capacity and Equivalent Series Resistance, Negative-electrode aging, Positive electrode aging, Sensitivity of voltage to Equivalent Series Resistance, Sensitivity of voltage to total capacity, Estimating SOH parameters via Kalman filters

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-5

Cell Balancing: Causes of imbalance, Balancer design choices, Circuits for balancing: Fixed shunt resistor, Switched shunt resistor, Multiple switched capacitors, One switched capacitor, Switched transformer, Shared transformer, Shared bus. **Power Limit estimation:** Terminal-voltage-based power limits, Voltage-based power limits, using a simple cell model, Rate limits based on SOC, maximum current, and power, Voltage-based power limits, using a full cell model.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:

Books

1. Gregory L. Plett, ***"Battery Management Systems, Vol. 1, Battery Modeling"***, Artech House, 2015.
2. Gregory L. Plett, ***"Battery Management Systems, Volume II, Equivalent-Circuit Methods"***, Artech House, 2016.
3. Rui Xiong, ***"Battery Management Algorithm for Electric Vehicles"***, Springer publications 2020.

Web links and Video Lectures (e-Resources):

https://www.classcentral.com/course/battery-management-systems-12083
https://nptel.ac.in/courses/108106022
https://nptel.ac.in/courses/108106182
https://archive.nptel.ac.in/courses/108/106/108106170/
https://nptel.ac.in/courses

Skill Development Activities Suggested

Semester- III

Energy Economics and Planning			
Course Code	22ESE332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: To provide students an understanding of the economic fundamentals and principles of decision making involved in energy projects. ♣ Students learn about cash flows, time value of money and evaluation of investments and projects. Express the imperative to focus on reducing fossil fuel based energy in the coming decades and associated opportunities this presents, with consideration of the inherent complexity.

Evaluate options to inform the development of industry strategies to profitably decouple greenhouse gas emissions from the operation of a range of industries, with specific examples.

Identify factors causing rising 'Peak' and 'Base' load electricity demand, and how renewable energy, energy management, and energy efficiency can reduce such demand.

Present how various forms of renewable energy can be generated, with consideration of strengths and

weaknesses of each Explain specific opportunities to reduce greenhouse gas emissions of a city, with specific reference to the 'Carbon Neutral Adelaide' program, and explain considerations related to their implementation in Adelaide Debate the relative pro's and con's of various options for reducing greenhouse gas emissions in specific industries from a technical, economic and policy context.
Module-1
Energy economics: Basic concepts, energy data, energy cost, energy balance. Energy accounting framework; Economic theory of demand, production and cost market structure; National energy map of India, Energy subsidy – National and international perspectives

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-2
Concepts of economic attributes involving renewable energy, Calculation of unit cost of power generation from different sources with examples, different models and methods Application of econometrics; input and output optimization; energy planning and forecasting - different methods.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-3
Concepts of economic attributes involving renewable energy, Calculation of unit cost of power generation from different sources with examples, different models and methods.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-4
Application of econometrics; input and output optimization; energy planning and forecasting - different methods Evaluation of National and Regional energy policies; oil import, energy conservation, rural energy economics, integrated energy planning

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-5
Conflict between energy consumption and environmental pollution, Economic approach to environmental protection and management, Energy-Environment interactions at different levels, energy efficiency, cost-benefit risk analysis; Project planning and implementation, Planning for energy security and renewable energy innovations; Regional, National and Global aspirations and requirements; Role of Governments, Societies and NGOs.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:

Books

1. Bhattacharyya S. C. (2011); *Energy Economics*, Springer
2. Ferdinand E. B. (2000); *Energy Economics: A Modern Introduction*, First Edition, Kluwer
3. Kandpal T. C. and Garg H. P. (2003); *Financial Evaluation of Renewable Energy Technology*, Macmilan
4. Stoft S. (2000); *Power Systems Economics*, Willey-Inter Science
5. Munasinghe M. and Meier P. (1993); *Energy Policy Analysis and Modeling*, Cambridge University Press
6. Samuelson P. A. and William D. N. (1992); *Economics*, 14th edition, McGraw Hill
7. Thuesen G. J. and Fabrycky W. J. (2001); *Engineering Economy*, Ninth Edition, Prentice Hall India

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/109106161
https://onlinecourses.nptel.ac.in/noc22_hs43/preview
https://nptel.ac.in/courses
https://elearn.nptel.ac.in/shop/nptel/energy-resources-economics-and-environment/

Skill Development Activities Suggested

Semester- III

Cyber Security in the electricity Sector			
Course Code	**22ESE333**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: By the end of this course, the students will learn to: Analyze the energy sector using a system-based approach, Proactively predict cyber security exposures and risks, Apply design thinking to create intrinsically secure and safe systems, Recognize emerging technology trends and implications, Effectively formulate cybersecurity strategy, policy, and compliance

Module-1

Introduction: Transformation, Dependence on the ICT, Cyber security, Priority Critical Infrastructure. State of Cyber security in the Electricity Sector: Introduction, Vulnerabilities, Threats, Challenges, Initiatives**.** Future Directions	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-2	
Cyber security Standards Applicable to the Electricity Sector: Introduction, Literature Search, Literature Analysis, Standards Selection and Evaluation Criteria, Results, Most Relevant Standards, Standards Implementation and Awareness.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-3	
A Systematic Approach to Cyber security Management: Introduction, Cyber security Management Approaches in Standards, The Systematic Approach to Cyber security Management in the Electricity Sector. Cyber security Assessment, Monitoring and Improvement.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-4	
Cost of Cyber security Management: Introduction, Economic Studies, Organisation Management Studies, Cost-Benefit Analysis, Cost Calculators, Costing Metrics, CAsPeA. Cyber security Assessment: Introduction, Security Assessment Methods for the Electricity Sector, Cyber security Test beds for Power Systems, JRC Cyber security Assessment Method, Laboratory Infrastructure.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-5	
Cyber security Controls: Introduction, Standard Technical Solutions, Information Sharing Platform on Cyber security Incidents for the Energy Sector. Situation Awareness Network.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

ssessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**

to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

Suggested Learning Resources:

Books

1. RafalLeszczyna "Cybersecurity in the Electricity Sector", Springer, 2019.
2. Rajesh Kumar Goutam, Cybersecurity Fundamentals, ISBN: 9789390684731, eISBN: 9789390684748, BPB publishers
3. Cyber Security and Laws Dr. Suvarna Shirke-Pansambal, ASIN : B0B7XFDH58, Publisher Tech Knowledge Publications; Course edition 2022.

Web links and Video Lectures (e-Resources):

https://cea.nic.in/wp-content/uploads/notification/2021/10/Guidelines_on_Cyber_Security_in_Power_Sector_2021-2.pdf
https://in.bpbonline.com/products/cybersecurity-fundamentals?variant=40422630359227&currency
https://onlinecourses.nptel.ac.in/noc22_cs23/preview
https://nptel.ac.in/courses/117107148

Skill Development Activities Suggested

Semester- III

IOT IN SMART GRID			
Course Code	22ESE334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	**3:0:0**	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives**:** to learn the implementation of the smart grid in the existing grid. 1. Studying the problem of existing grid. 2. Studying a conceptual model of Smart Grid 3. Studying the methods used in trainings and their implementation;

Module-1

Introduction to IoT: Introduction, Definition of IoT, Proposed architecture and Reference Models, Enabling technologies, challenges. **Organizational Implementation and Management Challenges in the Internet of things:** Introduction, IoT in Organizations, Managing IoT Systems.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-2

The Smart-Grid Concept: Introduction**,** Actors in the Smart-grid Environment: Grid operator, Grid users, Energy market place, Technology providers, Influencers. Challenges of Smart-grid: Inadequacies in Grid Infra Structure, Cyber Security, Storage Concern, Data Management, Communication Issues.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-3

Communication Protocols for the IoT-Based Smart Grid: Introduction, IoT Application types, IoT based Smart-Grid review, Current IoT Based Smart Grid Technology Enablers.

Smart Grid Hardware Security: Introduction, Smart Grid Architecture Patterns, Hardware Device Authentication, Confidentiality of Power Usage, Integrity of Data, Software and Hardware.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-4

Solar Energy Forecasting in the Era of IoT Enabled Smart Grids: Introduction, The Future Role of Forecasting, Summary of Solar Forecasting Methods, Example of a Detailed, Short-Term Forecasting Method.

Intelligence in IoT-enabled Smart Cities: Energy Consumption monitoring in IoT based smart cities, Smart homes in the crowd of IoT based cities, Smart meters for the smart city's grid, Intelligent parking solutions in IoT based smart cities.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Module-5

The Internet of Things in Electric Distribution Networks: Introduction, Current Control and Communication Provision in DNOs, AuRA-NMS-Based Electric IoT Architecture, Communication Standards, Protocols, and Requirements of Electric IoT. **Satellite-Based Internet of Things Infrastructure for Management of Large-Scale Electric Distribution Networks:** Introduction, Distributed Control Approach for Smart Distribution Grid, LEO Network Characteristics and Modeling, Communication Performance Assessment.

Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:

Books

1. Qusay F. Hassan, Atta ur Rehman Khan, Sajjad A. Madani, *"Internet of Things: Challenges, Advances, and Applications"*, 1st edition, CRC Press, Taylor and Francis group, 2019.
2. Kostas Siozios , DimitriosAnagnostos, DimitriosSoudris, Elias Kosmatopoulos, *"IoT for Smart Grids: Design Challenges and Paradigms"*, Springer, 2019
3. Fadi Al-Turjman, *"Intelligence in IoT-enabled Smart Cities"*, 1st edition, CRC, Press , 2018

Web links and Video Lectures (e-Resources):

https://www.ieee.org/education/academy-index.html?gclid=EAIaIQobChMIvpTywfnk-gIVRZpmAh2Rhw1LEAAYASAAEgKTZfD_BwE
https://nptel.ac.in/courses/108107113
https://www.digimat.in/nptel/courses/video/108107113/L01.html
https://www.digimat.in/nptel/courses/video/108107113/L03.html
https://www.digimat.in/nptel/courses/video/108107113/L28.html

Skill Development Activities Suggested

Semester- II

Thermal Power Plant Engineering			
Course Code	22ESE335	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	

Course Learning objectives: To study the power generation scenario, the components of thermal power plant, improved Rankin cycle, Cogeneration cycle. 2. To understand details of steam condensing plant, analysis of condenser, the environmental impacts of thermal power plant, method to reduce various pollution from thermal power plant. 3. To study layout, component details of hydroelectric power plant, hydrology and elements, types of nuclear power plant. 4. To understand components; layout of diesel power plant , components; different cycles ; methods to improve thermal efficiency of gas power plant 5. To study the working principle, construction of power generation from non-conventional sources of energy. 6. To learn the different instrumentation in power plant and basics of economics of power generation	
Module-1	
Overview of power plant, Types of thermal power plants, Steam power plant based on fossil fuels	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-2	
Thermal power plant equipment: boilers, super heaters, reheaters, economiser, condensers, and gas loops, turbines etc. Performance of steam power plant and its components	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-3	
Gas turbine power plant: different components, operating principles and design of Gas Turbine power plant, Gas Turbine-Steam Turbine combined cycle power plant	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-4	
Diesel electric power plant: different components, operating principles and design of Diesel electric power plant.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos
Module-5	
Economics, load management and environmental implications; recent advances in power plants: Clean coal technologies such as Fluidized Bed, IGCC etc.	
Teaching-Learning Process	Chalk & Talk, Power Point Presentation, Videos

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

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to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
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4. Each full question will have a sub-question covering all the topics under a module

Suggested Learning Resources:Books

1. Veatch B. Drbal L. F. Boston P. G. Westra K. L. and Erickson R. B. (2005); *Power Plant Engineering*,
2. Nag P. K. (2014); *Power Plant Engineering*, Fourth Edition, McGraw Hill Education India
3. Rajput R. K. (2007); *A Textbook of Power Plant Engineering*, Fourth edition, Laxmi
4. EI-Wakil M. M. (2010); *Power Plant Technology*, Tata McGraw-Hill
5. Ganesan, Y. (2003); *Internal Combustion Engines*, Tata McGraw-Hill
6. Gupta M. K. (2012); *Power Plant Engineering*, Prentice Hall India
7. Sarkar D. (2015); *Thermal Power Plant: Design and Operation*, Elsevier

Web links and Video Lectures (e-Resources):

https://www.google.co.in/search?biw=1536&bih=722&q=Thermal+Power+Plant+Engineering+NPTEL+COURSES
https://onlinecourses.nptel.ac.in/noc22_me73/preview
https://archive.nptel.ac.in/courses/112/107/112107291/
https://www.digimat.in/nptel/courses/video/112107291/L01.html

Skill Development Activities Suggested