BASAVESHWAR ENGINEERING COLLEGE(AUTONOMOUS), BAGALKOT
DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING

COURSE PLAN

Title of Course	**:**	**Elements of Electrical Engineering**	**Course Code**	**:**	**22UEE115C**
Credits	**:**	**03**	**Contact Hours/ Week**	**:**	**03**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**00**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**I**	**Year**	**:**	**2023-24**

Course Objectives:

After completion of the course, students should be able to

- Identify various components of Hydel, Thermal and Nuclear power plants and explain the overall operation of the power plants
- Use the basics of magnetic circuits, electromagnetism, single phase & three phase circuits and apply them to analyse given electrical circuit.
- Use mesh current analysis and node voltage analysis to find the current and voltages of a given electric circuit.
- Calculate different parameters related to magnetic circuits, single phase & three phase AC circuits and energy consumption.

Course Outcomes:

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

- Identify various components of Hydel, Thermal and Nuclear power plants
- Apply the basics of magnetic circuits, electromagnetism, single phase & three phase circuits to analyse given electrical circuit.
- Use mesh current analysis and node voltage analysis to find the current and voltages of a given electric circuit.
- Calculate different parameters related to magnetic circuits, single phase & three phase AC circuits and energy consumption.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

Sl.	Programme Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	Identify various components of Hydel, Thermal and Nuclear power plants	3	-	-	-	-	-	-	-	-	-	-	-
2	Apply the basics of magnetic circuits, electromagnetism, single phase & three phase circuits to analyse given electrical circuit.	3	2	-	-	-	-	-	-	-	-	-	-
3	Use mesh current analysis and node voltage analysis to find the current and voltages of a given electric circuit.	3	2	-	1	-	-	-	-	-	-	-	-
4	Calculate different parameters related to magnetic circuits, single phase & three phase AC circuits and energy consumption.	3	3	-	1	-	-	-	-	-	-	-	-

Competencies Addressed in the course and Corresponding Performance Indicators

Programme Outcome: Any of 1 to 12 PO's:

PO	Competency		Performance Indicators	
1	1.1	Demonstrate an ability to describe and derive the basics of magnetic circuits, electromagnetism, DC & AC circuits, electrical earthing	1.1.1	Apply mathematical techniques such as calculus, linear algebra, trigonometry, geometry to describe and derive the expressions / process / principle
	1.2	Demonstrate competence in electrical engineering fundamentals	1.2.1	Apply fundamental & electrical engineering concepts to solve engineering problems
2	2.1	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.1.1	Reframe complex problems into interconnected sub-problems
			2.1.2	Compare and contrast alternative solution processes to select the best process
4	4.1	Demonstrate an ability to analyze data and reach a valid conclusion	4.1.1	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate

consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO**8.** Ethics**:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL	PI addressed
	Unit -II			
1.	Students shall be able to explain electrical power generation by conventional methods; Hydel, Thermal and Nuclear	**2**	**2**	**2.1.2**
2.	Students shall be able to list the factors to be considered for site selection of power plants	**1**	**1**	**1.2.1**
3.	Students shall be able to define basic terms associated with electromagnetism	**1**	**1**	**1.1.1**
4.	Students shall be able to differentiate between series and parallel magnetic circuits	**2**	**2**	**2.1.2**
5.	Students shall be able to assess the ampere turns requirements for a given magnetic circuit of composite materials	**2**	**2**	**1.1.1**
6.	Students shall be able to state and illustrate the laws of electromagnetic induction	**2**	**2**	**1.1.1**
7.	Students shall be able to derive the expression for statically, dynamically induced emf's and coefficient of mutual coupling	**2**	**2**	**1.1.1**
	Unit -II			
8.	Students shall be able to apply Ohms law to electrical circuit for	**3**	**3**	**1.1.1**

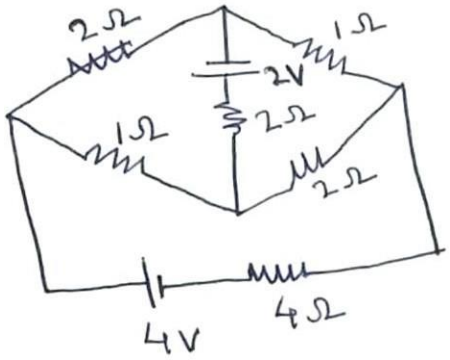
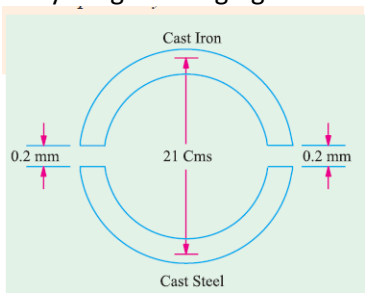
	determining the circuit parameters			
9.	Students shall be able to apply KVL and KCL to electrical circuit for determining the circuit parameters	**3**	**3**	**1.1.1**
10.	Students shall be able to analyse series, parallel and series-parallel circuits	**2**	**2**	**2.1.2**
11.	Students shall be able to simplify circuit using source transformation and shifting	**3**	**3**	**2.2.2**
12.	Students shall be able to find out the circuit parameters using mesh current analysis, node voltage analysis.	**3**	**3**	**2.1.2**
13.	Students shall be able to solve numerical problems associated with DC circuits	**5**	**4**	**1.2.1, 2.1.1**
Unit -III				
14.	Students shall be able to define basic terms associated with AC sinusoidal waveform	**1**	**1**	**1.1.1**
15.	Students shall be able to explain the generation of AC voltages	**2**	**2**	**1.1.1**
16.	Students shall be able to describe operator "j" and its properties	**2**	**2**	**1.1.1**
17.	Students shall be able to derive the Voltage and Current relationship in R, L and C	**3**	**3**	**1.1.1**
18.	Students shall be able to derive expression for Instantaneous and Average power in the series and parallel circuits with different combinations of R, L and C	**3**	**3**	**1.1.1**
19.	Students shall be able to list advantages of three phase system over single phase systems	**1**	**1**	**2.1.2**
20.	Students shall be able to explain the generation of three phase AC voltages	**2**	**2**	**1.1.1**
21.	Students shall be able to derive relationship between phase and line components in star and delta connected systems	**3**	**3**	**2.1.2**
22.	Students shall be able to derive expression for measuring power and power factor using two wattmeter's for three phase systems	**3**	**3**	**1.1.1**
Unit -IV				
23.	Students shall be able to list and explain different types of electrical wiring,	**2**	**2**	**1.1.1**
24.	Students shall be able to explain Two way and three way control of switch.	**4**	**3**	**1.1.1**
25.	Students shall be able to identify and read Power rating of household appliances	**1**	**4**	**2.1.2**
26.	Students shall be able to calculate electricity bill for domestic consumers	**2**	**2**	**1.1.1**
27.	Students shall be able to understand Electric shock, effect of shock on body, factors affecting severity of shock, safety precautions.	**1**	**1**	**2.1.2**

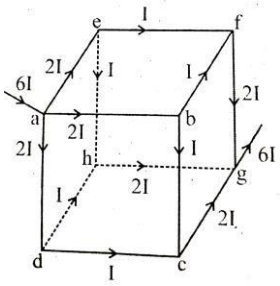
Course Content:

Hours Required	Topic to be covered	Mode of Delivery
01	**Electrical Power Generation:** Hydel plant- working principle, site selection parameters, merits and demerits.	**Power point presentation with Chalk and talk**
01	Thermal plant- working principle, site selection parameters, merits and demerits.	**Power point presentation with Chalk and talk**
01	Nuclear plant- working principle, site selection parameters, merits and demerits.	**Power point presentation with Chalk and talk**
01	**ELECTROMAGNETISM:** Properties of magnetic materials	**Chalk and talk**
01	Series and parallel magnetic circuits, Comparison between magnetic and electric circuits.	**Chalk and talk**
01	**Faradays law of electromagnetic induction**	**Chalk and talk**
01	Statically and dynamically induced emf	**Chalk and talk**
01	Self induced emf and mutually induced emf	**Chalk and talk**
01	Co-efficient of coupling	**Chalk and talk**
01	Problems on electromagnetism	**Chalk and talk**
01	**DC Circuits:** Ohm's law and Kirchhoff's laws,	**Chalk and talk**
01	Problems on KCL & KVL	**Chalk and talk**
01	Analysis of series, parallel and series-parallel circuits	**Chalk and talk**
01	Problems on series & parallel circuits,	**Chalk and talk**
01	Current and voltage sources, source transformation and shifting	**Chalk and talk**
01	Problems on source transformation and shifting	**Chalk and talk**
01	Dependent and independent sources, mesh current analysis	**Chalk and talk**
01	Problems on mesh current analysis	**Chalk and talk**
01	Node voltage analysis.	**Chalk and talk**
01	Problems on Node voltage analysis	**Chalk and talk**
01	**Single-Phase AC Circuits:** Generation of sinusoidal voltage	**Chalk and talk**
01	Average and rms values, form factor and peak factor	**Chalk and talk**
01	Phasor representation of alternating quantities	**Chalk and talk**
01	Analysis of R, L, C circuits with phasor diagrams	**Chalk and talk**

01	R-L, R-C, R-L-C circuits with phasor diagrams	**Chalk and talk**
01	Series, parallel and series-parallel circuits.	**Chalk and talk**
01	Problems on single phase circuits circuits	**Chalk and talk**
01	**Three-Phase AC Circuits:** Advantage of 3-phase system, generation of 3-phase power, Relationship between line and phase values of balanced star and delta connections	**Chalk and talk**
01	Power in balanced 3-phase circuits, measurement of 3-phase power by 2-wattmeter method.	**Chalk and talk**
01	Problems on 3 phase circuits	**Chalk and talk**
01	**Domestic Wiring:** Requirements, Types of wiring,	**Power point presentation with Chalk and talk**
01	Two way and three way control of switch	**Power point presentation with Chalk and talk**
01	**Electrical Energy Calculation:** Power rating of household appliances	**Power point presentation with Chalk and talk**
01	Two-part electricity tariff	**Power point presentation with Chalk and talk**
01	Problems on tariff	**Power point presentation with Chalk and talk**
01	Electricity bill for domestic consumers.	**Power point presentation with Chalk and talk**
01	Problems on billing	**Power point presentation with Chalk and talk**
01	**Electrical Safety Measures:** Equipment: Types of equipment,.	**Power point presentation with Chalk and talk**
01	Voltage and current issues, safety	**Power point presentation with Chalk and talk**
01	Human: Electric shock, effect of shock on body,	**Power point presentation with Chalk and talk**
01	Factors affecting severity of shock, safety precautions	**Power point presentation with Chalk and talk**

Review Questions:

Sl.	Review Questions	ULO	BLL	PI addressed
1	Find the current in 2V source shown in Fig. 1  Fig. 1	7	03	1.2.1
2	A ring has a diameter of 21 cm and a cross-sectional area of 10 cm2 shown in Fig.1.0. The ring is made up of semicircular sections of cast iron and cast steel, with each joint having a reluctance equal to an air-gap of 0.2 mm. Find the ampere-turns required to produce a flux of 8X10-4 Wb. The relative permeabilities of cast steel and cast iron are 800 and 166 respectively. Neglect fringing and leakage effects  Fig.6: Cast iron and cast steel	7	03	2.1.1
3	An iron ring has a X-section of 3 cm2 and a mean diameter of 25 cm. An air-gap of 0.4 mm has been cut across the section of the ring. The ring is wound with a coil of 200 turns through which a current of 2 A is passed. If the total magnetic flux is 0.24 mWb, find the relative permeability of iron, assuming no magnetic leakage	7	03	1.2.1
4	Find the impedance of a series RLC circuit if the inductive reactance, capacitive reactance and resistance are 184 Ω, 144 Ω and 30 Ω respectively. Also calculate the phase angle between voltage and current	16	03	1.2.1
5	A 400 mH coil of negligible resistance is connected to an AC circuit in which an effective current of 6 mA is flowing. Find out the voltage across the coil if the frequency is 1000 Hz	16	03	1.2.1
6	Each of the two wattmeters connected to measure the input to a 3 phase circuit reads 10 kW on a balanced load, when the power factor is unity. What does each instrument read when the power falls to 0.886 lag, the total 3 phase power remaining unchanged	24	03	
7	Describe the necessity of earthing with an equivalent circuit. Further, explain the different types of earthing	25	03	1.2.1

8	Define Magnetic flux, magnetic flux density, Reluctance, absolute permeability & relative permeability with their units and abbreviations	1	01	1.1.1
9	Define and describe Krichoff's voltage and current laws with an example	6	01	1.1.1
10	The circuit shown in Fig.3b shows a hollow cube of 12 wires, each having a resistance of r. Find the resistance between any two diagonally opposite corners.  Fig. 3b	7	04	4.1.1
11	Show that current lags the voltage by 90 degrees and the power consumed in a pure inductance circuit is zero	12	04	1.1.1
12	Explain the principle of dynamically induced EMF and derive the expression for induced voltage 'e'	5	02	1.1.1
13	A coil of 1000 turns is wound on a silicon steel ring having relative permeability of 1200. The ring has a mean diameter of 10 cm and cross sectional area of 12 sq.cm. When a current of 4 A flows through the coil, find the following. i. Flux in the core ii. Inductance of the coil iii. EMF induced in the coil if the flux falls to zero in 15 mS iv. Mutual inductance if another similar coil is placed such that 70% magnetic coupling exists between the coils	7	04	2.1.1

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	**20**	**20**
CIE-II	**20**	**20**
Assignments/ Quizzes	**10**	**10**
SEE	**100**	**50**
Total	**150**	**100**

Faculty Signature :

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BASAVESHWAR ENGINEERING COLLEGE(AUTONOMOUS), BAGALKOT

MODEL COURSE PLAN

Title of Course	**:**	**Introduction to Electrical Engineering**	**Course Code**	**:**	**22UEE116E**
Credits	**:**	**03**	**Contact Hours/ Week**	**:**	**03**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**00**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**1st and 2nd**	**Year**	**:**	**2023-24**

Prerequisites: Knowledge of Physics and Mathematics in Secondary Education.

Course Objectives:

	The Course objectives are:
1	To explain the laws used in the analysis of DC and AC circuits.
2	To explain the behaviour of circuit elements in single-phase circuits.
3	To explain the construction and operation of transformers, DC generators and motors.
4	To introduce concepts of circuit protecting devices and earthing.
5	To explain electric power generation, transmission and distribution, electricity billing, equipment and personal safety measures

Course Outcomes:

	At the end of the course the student should be able to:
1	Recall basics of DC Circuits, single phase and three phase circuits and electrical earthing.
2	Illustrate the laws of DC circuit, concept of single phase and three phase AC circuits domestic wiring practices and electricity generation principles, construction working principles applications of electrical machines and transformers.
3	Apply circuit laws and concepts to calculate different parameters of DC circuits, single phase and three phase AC circuits.
4	Evaluate the emf induced in generators and transformers under given conditions and asses energy consumption in domestic load.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
No	**Programme Outcomes / Course Outcomes**															
The students will be able to:																
1	**22UEE116E.1**	3	1	1			1	1	1		1		1	2	2	2
2	**22UEE116E.2**	3	1	1	1		1	1	1		1		1	3	2	3
3	**22UEE116E.3**	3	2	3	1								1	2	2	2
4	**22UEE116E.4**	3	3	3	2								1	3	2	3

Sl.	Unit Learning Outcome (ULO)	CO's	BLL	PI addressed
	Unit -I			
1.	Students shall be able to asses typical layout of power system network	**01**	**02**	**1.3.1**
2.	Students shall be able to explain electrical power generation by conventional methods; Hydel, Thermal and Nuclear	**01**	**02**	**1.4.1**
3.	Students shall be able to analyse series, parallel and series-parallel circuits	**01**	**03**	**2.2.3**
4.	Students shall be able to apply Ohms law to electrical circuit for determining the circuit parameters	**01**	**04**	**2.2.3**
5.	Students shall be able to apply KVL and KCL to electrical circuit for determining the circuit parameters	**01**	**04**	**2.2.3**
6.	Students shall be able to find out the circuit parameters using mesh current analysis, node voltage analysis.	**01**	**01**	**1.3.1**
7.	Students shall be able to solve numerical problems associated with DC circuits	**01**	**03**	**2.2.3**
	Unit -II			
8.	Students shall be able to define basic terms associated with AC sinusoidal waveform	**02**	**01**	**1.3.1**
9.	Students shall be able to explain the generation of AC voltages	**02**	**02**	**2.1.1**
10.	Students shall be able to derive the Voltage and Current relationship in R, L and C	**02**	**03**	**2.2.3**
11.	Students shall be able to derive expression for Instantaneous and Average power in the series and parallel circuits with different combinations of R, L and C	**02**	**03**	**2.2.3**
12.	Students shall be able to list advantages of three phase system over single phase systems	**02**	**01**	**1.3.1**
13.	Students shall be able to explain the generation of three phase AC voltages	**02**	**02**	**2.1.1**
14.	Students shall be able to derive relationship between phase and line components in star and delta connected systems	**02**	**03**	**2.2.3**
	Unit -III			
15.	Students shall be able to understand the construction and working of DC generator	**03**	**01**	**1.3.1**
16.	Students shall be able to list the different types of DC generators	**03**	**01**	**1.3.1**
17.	Students shall be able to list the application of DC generators	**03**	**01**	**1.3.1**
18.	Students shall be able to understand the construction and working of DC motors	**03**	**01**	**1.3.1**
19.	Students shall be able to list the different types of DC motors	**03**	**01**	**1.3.1**
20.	Students shall be able to list the application of DC motors	**03**	**01**	**1.3.1**
21.	Students shall be able to understand the construction and working of Transformers	**03**	**01**	**1.3.1**
22.	Students shall be able to list the different types of transformers	**03**	**01**	**1.3.1**
23.	Students shall be able to list the application of transformers	**03**	**01**	**1.3.1**
	Unit -IV			
24.	Students shall be able to list and calculate types of tariff in electricity	**04**	**01**	**1.3.1**
25.	Students shall be able to list and explain different types of electrical wiring,	**04**	**01**	**1.3.1**
26.	Students shall be able to explain Two way and three way control of switch.	**04**	**02**	**2.1.1**
27.	Students shall be able to identify and read Power rating of household appliances	**04**	**01**	**1.3.1**

28.	Students shall be able to calculate electricity bill for domestic consumers	**04**	**04**	**2.2.3**
29	Students shall be able to understand Electric shock, effect of shock on body, factors affecting severity of shock, safety precautions.	**04**	**01**	**1.3.1**

Competencies Addressed in the course and Corresponding Performance Indicators

Programme Outcome:Any of 1 to 12 PO's:

PO1: Engineering knowledge:Apply the knowledge of mathematics, science, engineering fundamentals, andan engineering specializationforthesolutionofcomplexengineeringproblems.			
	Competency	**PI**	**Indicators**
1.1	**Demonstratethecompetenceinsolvingengineeringmathematicalproblems**	**1.1.1**	**Applyfundamentalsofmathematicstosolveproblems**
		1.1.2	**Apply advancedmathematical techniquestomodellingand problemsolvinginelectricalengineering**
1.2	**Demonstratethecompetenceinbasic sciences**	**1.2.1**	**Applylawsofnaturalsciencetoanengineering problem**
1.3	**Demonstrate competence in engineering fundamentals**	**1.3.1**	**Applyelementsofelectricalengineeringprinciplesandlaws**
1.4	**DemonstratecompetenceinElectrical engineeringknowledge**	**1.4.1**	**Applydisciplinespecificlawsandprinciplestosolveanengineering problem**

PO2:Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineeringsciences.			
	Competency	**PI**	**Indicators**
2.1	**Demonstrateanabilitytoidentifyandcharacterizeanengineering problem**	**2.1.1**	**EvaluateproblemstatementsandIdentifyobjectives**
		2.1.2	**Identifyengineeringsystems,variables,andparameterstosolve theproblems**
		2.1.3	**Identify the mathematical, engineering and other relevant knowledgethatapplies toagivenproblem**
2.2	**Demonstrate an ability to formulate asolution plan and methodology for anengineeringproblem**	**2.2.1**	**Reframecomplexproblemsintointerconnectedsub-problems.**
		2.2.2	**Identify,assembleandevaluateinformationandresources.**
		2.2.3	**Identifyexistingprocesses/solutionmethodsforsolvingthe problem,includingjustifiedapproximationsandassumptions**
		2.2.4	**Compareandcontrastalternativesolution processestoselectthe bestprocess.**
2.3	**Demonstrateanabilitytoformulateandinterpret asystem/model**	**2.3.1**	**Combinescientificandengineeringprinciplestoformulatemodels (mathematicalorotherwise)ofasystemorprocessthatisappropriatei nterms ofapplicabilityandrequiredaccuracy.**
		2.3.2	**Identifyassumptions(mathematicalandphysical)necessaryto allowmodelling ofasystematthelevelofaccuracyrequired.**
2.4	**Demonstrate an ability to execute a solution, process and analyze results**	**2.4.1**	**Apply engineering mathematics and computations to solve (form & analyze) mathematical models.**
		2.4.2	**Produceandvalidateresultsthroughskilfuluseofcontemporary engineeringtoolsandmodels**
		2.4.3	**Identifysourcesoferrorinthesolutionprocess,andlimitationsof thesolution.**
		2.4.4	**Extractdesiredunderstandingandconclusionsconsistentwith objectivesandlimitationsoftheanalysis**

PO3: Design/Development of Solutions: Design/development of solutions: Design solutions for complexengineering problems and design system components or processes that meet the specified needs withappropriateconsiderationforpublichealthandsafety,andcultural,societal,andenvironmentalconsiderations.			
	Competency	PI	Indicators
3.1	Demonstrateanabilitytodefineacomplexopen-endedprobleminengineeringterms	3.1.1	Recognize that good problem definition assists in the design process
		3.1.2	Elicit and document engineering requirements from stakeholders
		3.1.3	Synthesize engineering requirements from are view of the State of the Art
		3.1.4	Extract engineering requirements from relevant engineeringCodesandStandards
		3.1.5	Explore and synthesize engineering requirements from larger social and professional concerns
		3.1.6	Determined sign objectives, functional requirements and arrive at specifications
3.2	Demonstrateanabilitytogenerateadiversesetofalternativedesignsolutions	3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
		3.2.2	Build models, prototypes, etc., to develop diverse set of design solutions
		3.2.3	Identify the suitable criteria for evaluation of alternate design solutions
3.3	Demonstrate an ability to select the optimal design scheme for further development	3.3.1	Apply for malmulti criteria decision making tools to select optimal engineering design solutions for further development
		3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4	Demonstrateanabilitytoadvanceanengineeringdesigntodefinedend state	3.4.1	Refine a conceptual design in to a detailed design with in the existing constraints(of the resources)
		3.4.2	Generatesinformationthroughappropriateteststo improve,orrevisedesignstates

PO4:Conductinvestigationsofcomplexproblems:Useresearch-basedknowledgeandresearchmethodsincludingdesignofexperiments,analysisandinterpretationofdata,andsynthesisoftheinformationtoprovidevalidconclusions.

	Competency	PI	Indicators
4.1	Demonstrateanabilitytoconductinvestigationsoftechnicalissuesconsistentwiththeirlevelofknowledgeandunderstanding	4.1.1	Defineaproblemforpurposeofinvestigation,itsscopeand importance
		4.1.2	Relate modern engineering experimentation including experiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Apply appropriate instrumentation, and/or software tools to make measurements of physical quantities
		4.1.4	Establishorvalidatearelationshipbetween measureddataand under lying physical principles.
4.2	Demonstrateanabilitytodesignexperimentstosolveopenendedproblems	4.2.1	Develop and design experimental approach, specify appropriate equipment and procedures, implement these procedures, and interpret there sulting data to characterize an engineering material, component, or system.
		4.2.2	Understand the importance of statistical design of experiments and choose an appropriate experimental design plan base don't he study objectives
4.3	Demonstrate an ability to criticallyanalyzedatatoreachavalidconclusion	4.3.1	Use appropriate procedures, tools and techniques to collect and analyze data
		4.3.2	Critically analyze data for trends and correlations, stating possible errors and limitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and draw conclusions
		4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions

PO5:Moderntoolusage:Create,select,andapplyappropriatetechniques,resources,andmodernengineering and IT tools including prediction and modelling to complex engineering activities with anunderstandingofthelimitations.

	Competency	PI	Indicators
5.1	Demonstrateanabilitytoidentify/createmodernengineeringtools, techniques andresources	5.1.1	Identifymodernengineeringtools,techniquesandresourcesfor engineeringactivities
		5.1.2	Create/adapt/modify/extendtoolsandtechniquestosolve problems
5.2	Demonstrate an ability to select andapplydisciplinespecifictools,techniques andresources	5.2.1	Identify the strengths and imitations of tools for(i)acquiring information,(ii)modellingandsimulation,(iii)monitoringsystemperformance, and(iv)creating engineering designs.
		5.2.2	Demonstrate proficiency in using computing, mathematical, circuitsimulation,anddocumentpresentation/preparationsoftware.(MATLAB /Scilab,PSPICE,SABER,PROTEUSsoftwaretools, AutoCAD,projectmanagementtools,Latexandothers)
5.3	Demonstrateanabilitytoevaluatethesuitability andlimitationsofthetools usedtosolveanengineering problem	5.3.1	Identifylimitationsandvalidatetools,techniquesandresources
		5.3.2	Verifythecredibilityof resultsfromtooluse with referencetothe accuracyandlimitations,andtheassumptionsinherentintheiruse.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal,health, safety, legal and cultural issues and the consequent responsibilities relevant to the professionalengineeringpractice.

	Competency	PI	Indicators
6.1	Demonstratetheabilitytodescribeengineeringrolesina broadercontext,e.g.aspertainstothe environment,health,safety, andpublicwelfare	6.1.1	Identify and describe various engineering roles;particularlypertainingtoprotectionofthepublicand publicinterest
6.1	Demonstrate an understanding of professionalengineeringregulations,legislationandsta ndards	6.2.1	Interpretlegislation,regulations,codes,andstandardsrelevanttoelect ricalandelectronicsengineeringdiscipline(suchasIEEE)andexplainitsc ontributiontothe protectionofthepublic

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions insocietalandenvironmentalcontexts,anddemonstratetheknowledgeof,andneedforsustainabledevelopment.

	Competency	PI	Indicators
7.1	Demonstrate an understanding of the impactofengineeringandindustrialpracticeonsocial ,environmentalandeconomiccontexts	7.1.1	Identifyrisks/impactsinthelife-cycleofanengineering productoractivity
		7.1.2	Demonstrateanunderstandingoftherelationshipbetweenthe technical, socio-economic and environmental dimensionsofsustainability
7.2	Demonstrateanabilitytoapplyprinciplesofsustaina bledesignanddevelopment	7.2.1	Describe management techniques for sustainable development
		7.2.2	Applyprinciplesofpreventiveengineeringandsustainable development to an engineering activity or product relevanttoElectricalandElectronicsEngineering

PO8:Ethics: Applyethicalprinciplesandcommittoprofessionalethics,responsibilitiesandnormsofthe engineeringpractice.

	Competency	PI	Indicators
8.1	Demonstrateanabilitytorecognizeethical dilemmas	8.1.1	Identifysituationsofunethicalprofessionalconductand proposeethicalalternatives
8.2	Demonstrate an ability to applytheCode of Ethics	8.2.1	Identifytenets oftheIEEEprofessionalcodeofethics
		8.2.2	Examineandapplymoral&ethicalprinciplestohistorically famous casestudies

PO9:Individualandteamwork: Functioneffectivelyasanindividual,andasamemberorleaderindiverseteams, andinmultidisciplinary settings.

	Competency	PI	Indicators
9.1	Demonstrateanabilitytoformateamanddefinearol eforeachmember	9.1.1	Recognizeavarietyofworkingandlearningpreferences; appreciatethevalueof diversityinateam
		9.1.2	Implementthenormsofpractice(e.g.rules,roles,charters, agendas,etc.)ofeffectiveteamwork,toaccomplishagoal.
9.2	Demonstrateeffectiveindividual&teamoperations -- communication, problem solving,resolution&leadershipskills	9.2.1	Demonstrateeffectivecommunication, problemsolving,conflictresolutionandleadershipskills
9.3	Demonstratesuccessinateam-basedproject	9.3.1	Presentresultsasateam,withsmoothintegrationof contributionsfromallindividualefforts

PO10:Communication:Communicateeffectivelyoncomplexengineeringactivitieswiththeengineeringcommunityandwiththesocietyatlarge,suchas,beingabletocomprehendandwriteeffectivereportsanddesigndocumentation,makeeffectivepresentations,andgiveandreceiveclearinstructions			
	Competency	PI	Indicators
10.1	Demonstrateanabilitytocomprehendtechnical literature and documentprojectwork.	10.1.1	Read,understandandinterprettechnicalandnon-technical information
		10.1.2	Produce clear, well-constructed, and well-supported writtenengineeringdocuments
		10.1.3	Create*flow*inadocumentorpresentation–alogical progressionofideassothatthemainpointisclear
10.2	Demonstrate competence in listening,speaking, andpresentation	10.2.1	Listentoandcomprehendinformation,instructions,and viewpointofothers
		10.2.2	Delivereffectiveoralpresentationstotechnicalandnon-technicalaudiences
10.3	Demonstrate the ability to integratedifferentmodesofcommunication	10.3.1	Createengineering-standardfigures,reportsanddrawings tocomplementwritingandpresentations
		10.3.2	Useavarietyofmediaeffectivelyto conveyamessageina documentorapresentation

PO11:Projectmanagementandfinance:Demonstrateknowledgeandunderstandingoftheengineeringandmanagement principles and apply these to one's own work, as a member and leader in a team, to manageprojects andinmultidisciplinary environments.			
	Competency	PI	Indicators
11.1	Demonstrateanabilitytoevaluatetheeconomic and financial performance of anengineeringactivity	11.1.1	Describevariouseconomicandfinancialcosts/benefitsof anengineeringactivity
		11.1.2	Analyzedifferentformsoffinancialstatementstoevaluate thefinancialstatusofanengineering project
11.2	DemonstrateandabilitytoCompareandcontrastthecosts/benefitsofalternate proposalsforanengineeringactivity	11.2.2	Analyzeandselectthemostappropriateproposalbasedoneconomicandfinancialconsiderations.
11.3	Demonstrateanability to plan/manageanengineeringactivitywithintimeandbudgetconstraints	11.3.1	Identifythetasksrequiredtocompleteanengineering Activity,andtheresourcesrequiredtocompletethetasks.
		11.3.2	Useprojectmanagementtoolsto scheduleanengineering Projectsoastocompleteontimeandwithinbudget.

PO12:Life-longlearning:Recognisetheneedforandhavethepreparationandabilitytoengageinindependentandlife-longlearninginthebroadestcontextoftechnologicalchange.			
	Competency	PI	Indicators
12.1	Demonstrate an ability to identify gaps inknowledgeandastrategytoclosethesegaps	12.1.1	Describe the rationale behind the requirement for continuingprofessionaldevelopment
		12.1.2	Identify deficiencies or gaps in knowledge anddemonstrateanabilitytosourceinformationtobridge the same
12.2	Demonstrate an ability to Identify changingtrendsinengineeringknowledgeandpractice	12.2.1	Identifyhistoricpointsoftechnologicaladvanceinengineeringthatrequirepractitionerstoseekeducationin ordertostayupdated
		12.2.2	Recognize theneed andbe ableto clearlyexplainwhyitisvitallyimportanttokeepupdatedregardingnew developmentsinthefield
12.3	Demonstrateanabilitytoidentifyandaccess sourcesfor newinformation	12.3.1	Demonstrateanabilitytosourceandcomprehendtechnicalliterature andothercrediblesourcesof information
		12.3.2	Demonstrate an ability to critically analyze sourced technicaland popular information forfeasibility, viabilityandsustainability

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Content:

Hours Required	Topic to be covered	Mode of Delivery
01	General Structure of electrical Power System using single line diagram approach	**Chalk and talk in classroom/Lecture combined with discussions**
01	Hydel Power Plant, Thermal Power Plant (Block Diagram Approach)	
01	Nuclear Power Plant (Block Diagram Approach)	
01	OHM's Law and its limitations, KVL and KCL	
01	Problems on OHMS law	
01	Problems on KVL, KCL	
01	Definitions on Series, Series-Parallel circuits	
01	Problems on Series Circuits	
01	Problems on Series- Parallel circuits	
01	Problems on Series- Parallel circuits	
01	Definitions on Equation on AC Voltage, Current, waveform, time period, frequency, amplitude, phase, phase difference,	**Chalk and talk in classroom/Lecture combined with discussions**
01	Average value, RMS value, Form factor, peak factor (Only Definitions)	
01	Voltage and Current relationship with phasors diagrams in R, L, and C Circuits	
01	Voltage and Current relationship with phasors diagrams in R, L, and C Circuits	
01	Concept on impedance analysis of R-L, R-C and R-L-C series circuits	
01	Active power, Reactive power and apparent power and concept on power factor	
01	Simple numerical	
01	Generation of three phase AC quantity, Advantages and Dis-Advantages and limitations	
01	Star and delta connections	
01	Relationship between line and phase quantities (excluding proof)	
01	Working principal of DC Generator, construction equations,	**Chalk and talk in classroom/Lecture combined with discussions**
01	Types and classifications, specifications	
01	Applications, cost and simple numerical problems	
01	Working principal of DC Motor, construction equations,	
01	Types and classifications, specifications	
01	Applications, cost and simple numerical problems	

01	Working principal of Transformer, construction equations,	
01	Types and classifications, specifications	
01	Applications, cost and simple numerical problems	
01	simple numerical problems	
01	Requirements, Types of wiring,	**Chalk and talk in classroom/Lecture combined with discussions**
01	Two way and three way control of loads	
01	Power rating of household appliances, two-part electricity tariff	
01	Calculation of electricity bill for domestic consumers.	
01	Calculation of electricity bill for domestic consumers.	
01	Types of equipment for safety, voltage and current issues	
01	Electric shock on humans,	
01	Effect of shocks on body,	
01	Factors affecting severity of shocks	
01	Safety precautions	

Review Questions:

Review Questions	CO	BLL	PI addressed
State ohm's law and its limitations.	**1**	**1**	**1.3.1**
With the help of single line diagram explain the power transmission and distribution network.	**1**	**1**	**1.3.1**
State Kirchhoff's Current law.	**1**	**1**	**1.3.1**
State Kirchhoff's Voltage law.	**1**	**1**	**1.3.1**
Write down the expression of equivalent resistance for 'n' – number of resistors in series connection.	**1**	**1**	**1.3.1**
Write down the expression of equivalent resistance for 'n'- number of resistors in parallel connection	**1**	**1**	**1.3.1**
A resistance R is connected in series with a parallel circuit comprising two resistances of 12 Ω and 8Ω respectively. The total power dissipated in the circuit is 70 W when the applied voltage is 20V. Calculate R.	**1**	**4**	**2.2.3**
Two batteries of 24V and 20V with internal resistances of 0.4Ω and 0.25Ω respectively are connected in parallel across a load of 4Ω. Calculate (i) the current supplied by each battery and (ii) voltage across the load.	**1**	**4**	**2.2.3**
A resistance R is connected in series with a parallel circuit comprising of resistances of 4Ω and 6Ω respectively. When the applied voltage is 15V, the power dissipated in 4Ω resistor is 36W, calculate R.	**1**	**4**	**2.2.3**
With block diagram explain hydel power generation.	**1**	**2**	**1.4.1**
With block diagram explain nuclear power generation.	**1**	**2**	**1.4.1**
With block diagram explain thermal power generation.	**1**	**2**	**1.4.1**
Define the following by referring a sine wave i) RMS value ii) average value iii) form factor iv) peak factor v) phase and vi) phase difference.	**2**	**1**	**1.3.1**
Show that the current through purely capacitive circuit leads the applied voltage by 90º and average power consumed is zero. Draw the wave shapes of current, voltage and power.	**2**	**3**	**2.1.1**
An inductive coil takes a current of 10A from a supply of 100V, 50Hz and lags the voltage by 30º. Calculate i) parameters of the circuit ii) power factor iii) active, reactive and apparent power.	**2**	**3**	**2.1.1**
With the help of circuit diagram and phasor diagram, find the phase angle, impedance and power in case of R-L series circuit.	**2**	**1**	**1.3.1**
Define Impedance	**2**	**1**	**1.3.1**
With a neat diagram explain the construction of D.C. generator	**2**	**2**	**2.1.1**

Derive an expression of armature torque developed in a D. C. motor	**3**	**3**	**2.1.3**
An 8 pole generator has 500 armature conductors and has a useful flux per pole of 0.065wb. What will be the emf generated if it is lap connected and runs at 1000rpm? What must be the speed at which it is to be driven to produce the same emf if it is wave wound?	**3**	**4**	**2.2.3**
Derive the emf equation of a transformer and hence obtain the voltage and current transformation ratios.	**3**	**3**	**2.1.3**
Explain the various losses in a transformer and how to minimize them?	**3**	**2**	**2.1.1**
With usual notations derive an emf equation of D.C. generator.	**3**	**3**	**2.1.3**
Define power factor.	**3**	**1**	**1.3.1**
Define real power, reactive power and apparent power.	**3**	**1**	**1.3.1**
With neat circuit diagram and switching table explain two way and three way control of load	**4**	**2**	**2.1.1**
Define "unit" used for consumption of electrical energy and explain the two part tariff with its advantages and disadvantages	**4**	**1**	**1.3.1**
What is electric shock? Give the list of preventive measures against the shock.	**4**	**1**	**1.3.1**
List out the power rating of household appliances including air conditioners, PCs, laptops, printers, etc. Find the total power consumed.	**4**	**1**	**1.3.1**
Define fuse? Explain the working of fuse with neat diagram.	**4**	**1**	**1.3.1**
Define electric shock? What are the safety precaution to be taken against to avoid electric shock.	**4**	**1**	**1.3.1**
Define unit and tariff? Explain the two part tariff with its merits and de-merits.	**4**	**2**	**1.3.1**

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	**20**	**20**
CIE-II	**20**	**20**
Assignments/ Quizzes/ Case Study/ Course Project/ Term Paper/Field Work	**10**	**10**
SEE	**100**	**50**
Total	**150**	**100**

Details of Assignment:

Assignment	Marks (10)	CO	PI	CA	PO
Assignment 1	**Case study (05M)**	**1,2,3,4**	**1.3.1,1.4.1, 2.1.1,2.1.3, 2.2.3,**	**1.3,1.4,2.1, 2.2, 2.4**	**01,02,03,04,12**
Assignment 2	**Quiz (05M)**	**1,2,3,4**	**1.3.1, 1.4.1**	**1.3,1.4**	**01,02,03,04,12**

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BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOT

MODEL COURSEPLAN

Title of Course	**:**	**Renewable Energy Sources**	**Course Code**	**:**	**22UEE136B**
Credits	**:**	**3**	**Contact Hours/ Week**	**:**	**3**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**40**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**100**
Semester	**:**	**I**	**Year**	**:**	**2023**

Prerequisites:

Course Objectives:

	The Course objectives are:
1	To identify the parameters required for solar, wind, biomass, geothermal and ocean energy conversion systems.
2	To apply and analyze concepts and theory related to solar, wind, biomass, geothermal and ocean energy conversion systems
3	To derive power output of solar and wind energy conversion systems based on the corresponding solar irradiation and wind speed respectively
4	To analyze pros and cons of solar, wind, biomass, geothermal and ocean energy conversion systems

Course Outcomes:

	At the end of the course the student should be able to:
1	Identify electrical and mechanical devices of solar, wind, biomass, geothermal and ocean energy conversion systems.
2	Illustrate performance parameters related to solar, wind, biomass, geothermal and ocean energy conversion systems.
3	Compute the power generation of wind and solar energy correspond to variable data.
4	Compare the features of solar, wind, biomass, geothermal and ocean energy conversion systems.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

		PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO1	PSO2	PSO3
No	**Programme Outcomes / Course Outcomes**															
The students will be able to:																
1	22UEE136B.1	**3**	**1**	**1**			**1**	**1**	**1**		**1**	**1**	**1**	**3**	**1**	
2	22UEE136B.2	**3**	**1**	**1**	**1**		**1**	**1**	**1**		**1**		**1**	**2**	**3**	
3	22UEE136B.3	**3**	**2**	**3**	**1**							**1**	**1**	**1**	**1**	
4	22UEE136B.4	**3**	**3**	**3**	**2**				**1**				**1**	**1**		**1**

Competencies Addressed in the course and Corresponding Performance Indicators

Programme Outcome:Any of 1 to 12 PO's:

P0	Competency		Indicators
1	Knowledge of Conventional and Non-conventional Energy Resources		• Understand the principles of Conventional and Non-conventional Energy Resources • Explain the characteristics of Conventional and Non-conventional Energy Resources. • Describe the solar spectrum, wind velocity, biomass and how it affects the performance.
2	Working principle and importance of solar, wind biomass, geothermal and ocean energy sources		• Identify different PV module technologies, wind turbine types and their advantages/disadvantages. • Understand the function and selection of PV module technologies, wind turbine.
7	Applications of solar, wind biomass, geothermal and ocean energy sources		• Calculate the power output from PV and wind energy system based on input sources. • Determine the appropriate battery bank size (if off-grid).
12	Compare and contrast the renewable energy sources		• Differentiate between available renewable energy sources.

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL	PI addressed
	Unit -I1			
1.	Students should be able to define basic terms associated with conventional and non-conventional energy sources.	**1**	**1**	**1.1.1**
2.	Students should be able to differentiate between conventional and non-conventional energy sources.	**2**	**2**	**2.1.2**
3.	Students shouldbe able to assess the scenario of renewable energy sources in global and India.	**2**	**2**	**1.1.1**
4.	Students should be able to state and illustrate the solar radiation data in terrestrial and extra-terrestrial region.	**2**	**2**	**1.1.1**
	Unit -II			
5.	Students shall be able to define basic terms associated with SPVthermal devices and module–Ratings,standardparameters	**1**	**1**	**1.1.1**
6.	Students should be able to describe applications of SPV	**2**	**2**	**1.1.1**

Unit -III				
7.	Students should be able to describe the working principle and derivation of the power from WECS	**2**	**2**	**1.1.1**
8.	Students should be able to compare the various classification of WECS	**2**	**2**	**1.1.1**
9.	Students should be able to describe the working principle of Biomass conversion technologies	**2**	**2**	**2.1.2**
10.	Students should be able to compare the various classification of Biomass conversion technologies	**3**	**3**	**3.1.2**
Unit -IV				
11.	Students should be able to describe the working principle of geothermal conversion conversion technologies	**2**	**2**	**1.1.1**
12.	Students should be able to describe the working principle of Tidal Power Plant	**1**	**4**	**2.1.2**
13.	Students should be able to describe the working principle of OTEC system	**2**	**2**	**1.1.1**

Course Content:

Hours Required	Topic to be covered	Mode of Delivery
01	Introduction to Energy Sources: Classification of energy resources	Chalk and talk in classroom/Lecture combined with discussions/Lecture with a quiz/ Tutorial/ Assignments/ Demonstration/ Invited lectures/ Group Assignment/
01	conventional energy resources – availability and their limitations;	
01	non-conventional energy resources – classification, advantages, limitations	
01	comparison of conventional and non-conventional energy resources.	
01	Solar Energy Basics:Introduction,	
01	Solar constant	
01	basic sun-earth angles – definitions	
01	solar radiation geometry	
01	solar radiation data measuring instruments – Pyranometer and Pyrheliometer.	
01	Summary of solar energy basics	
01	Solar thermal systems, Principle of conversion of solar radiation into heat	
01	solar water heaters	
01	solar cookers – box type, concentrating dish type	
01	solar driers, solar still.	
01	Solar thermal electric power generation	
01	solar pond and concentrating solar collector (parabolic trough, parabolic dish, central tower collector)	
01	Advantages and disadvantages of solar thermal system	
01	solar photovoltaic – solar cell fundamentals,	

01	module, panel and array;	
01	solar PV systems – street lighting, domestic lighting and solar water pumping systems.	
01	Wires–Introduction	
01	Basicsofcurrentconduction,typesofwires	
01	Wind Energy: Wind and its properties	
01	History of wind energy,basic principles of Wind Energy Conversion Systems (WECS),	
01	Savinous and Darrius types	
01	Advantages and limitations of WECS.	
01	Biomass Energy: Introduction, photosynthesis process	
01	biomass conversion technologies	
01	biomass gasification – principle	
01	working of gasifiers	
01	factors affecting biogas generation, types of biogas plants–KVIC and Janata model.	
01	Geothermal Energy: Introduction, classification, conversion technologies	
01	applications, advantages and limitations of geothermal resources.	
01	Energy from Ocean: Principle of tidal power, components of Tidal Power Plant (TPP)	
01	classification, advantages and limitations of TPP.	
01	Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system	
01	Types of OTEC power generation	
01	Block diagram, applications	
01	Advantages and limitations of OTEC	
01	Summary of Renewable Energy Sources	

Review Questions:

Review Questions	ULO	BLL	PI addressed
List the various classification of Energy Sources	1	4	1.1.1
Write the total installed capacity of following renewable energy sources in India and global as on 2022. (i) Wind Turbine Generator (ii) Solar PV	2	2	2.1.2
With neat diagram and characteristics, define the following radiation geometry: latitude, declination, hour angle, solar azimuth angle.	3	2	1.1.1
Under which of the following condition a typical silicon PV cell produces about 0.5 – 0.6 volt DC?	4	2	1.1.1
Modified FPC and Compound Parabolic Concentrating (CPC) belongs to which of the following type of solar collectors?	5	3	1.1.1
A solar PV panel installed at Bagalkot generates 6 kWh of energy per hour. Calculate the energy generated by the same solar panel on 12th September 2019. (Coordinates for Bagalkot are 16.1691˚ N, 75.6615˚ E)	6	3	1.2.1, 2.1.1
List the classification of various types of solar collectors.	6	1	1.1.1
Compare and contrast the box and paraboloidal dish type solar cooker.	6	1	2.1.2
How hot spot effect on solar cells and solution with neat diagram.	5	1	1.1.1
Functions of solar incident on green plants and photosynthetic organisms are,	7	1	1.1.1
Derive the expression of power in the vertical axis wind turbine generator.	8	1	1.1.1
Explain the two stage process of photosynthesis	10	2	1.1.1
Explain the biomass conversion technologies: Incineration and Pyrolysis.	9	4	2.1.2
Write the difference between hydrothermal and hot dry rocks of energy sources.	11,12	2	1.1.1
Illustrate, the bulges at near and far side of earth and what is the one tidal cycle.	13	2	1.1.1

Evaluation Scheme:

Assessment	Marks	Weightage
CIE-I	**20**	**20**
CIE-II	**20**	**20**
Assignments/ Quizzes/ Case Study/ Course Project/ Term Paper/Field Work	**10**	**10**
SEE	**100**	**50**
Total	**150**	**100**

Details of Assignment:

Assignment	Marks (10)	CO	PI	CA	PO
Assignment 1	**5**	**3,4**	1.2.1, 2.1.1	1.1, 2.1	1,2
Assignment 2	**5**	**3,4**	2.1.2, 4.1.1	2.1, 4.1	2, 4

Faculty Incharge:

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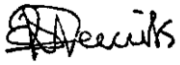

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