BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOT

COURSE PLAN

Title of Course	**:**	**Computational Techniques for Electrical System-I**	**Course Code**	**:**	**22UMA303C**
Credits	**:**	**03(L-T-P: 3-0-0)**	**Contact Hours/ Week**	**:**	**03**
Total Hours	**:**	**40**			
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**III**	**Year**	**:**	**2022-2023**

Course Objectives: This course will enable students to

1	articulate clear and concise definitions of signals and systems, demonstrating a fundamental understanding of the key concepts and their role in the field of signals and systems.
2	to solve problems involving these operations and understand their implications in signal processing and system analysis.
3	to apply these concepts to analyze and design systems in practical engineering applications by the end of the course.
4	Explore the conditions for causality and stability in the Z-domain and their implications on system analysis and design.
5	Develop the ability to choose appropriate Fourier techniques for analyzing and processing different types of signals, both in continuous-time and frequency domains.

Course Outcomes:

	After completion of the course the students shall be able to
1	Represent signals and perform the basic operations on signals and to identify systems properties on causality, stability, memory, linearity and time invariance **(BLL 1)**
2	Illustrate- Continuous time systems and discrete time system by performing Convolution in LTI system with properties of impulse response **(BLL 2)**
3	Analyze and Derive the Z transforms and properties of Z transform by using the concept of ROC **(BLL 3)**
4	Determine Fourier series and properties of Fourier series in CTFS and CTFT signals **(BLL 4)**

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

Sl.	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	Students shall be able to Represent signals and perform the basic operations on signals and to identify systems properties on causality, stability memory, linearity, and time invariance.	**2**	**3**										**1**
2	Students shall be able to illustrate Continuous time system and discrete time system by performing Convolution in LTI system and with properties of impulse response.	**3**	**1**	**2**	**1**								**1**
3	Students shall be able to Analyze and Derive the Z transforms and properties of Z transform by using the concept of ROC.	**3**	**3**	**1**	**1**								**1**
4	Students shall be able to Determine Fourier series and properties of Fourier series in CTFS signals.	**3**	**3**	**2**	**2**								**1**
5	Students shall be able to Determine Fourier series and properties of Fourier series in CTFT signals.	**3**	**3**	**2**	**2**								**1**

Competencies Addressed in the course and Corresponding Performance Indicators
Programme Outcome: Any of 1 to 12 PO's:

Competency	Indicators	
1.1 Apply the knowledge of Mathematics to the solution of Electrical Engineering problems.	1.1.1	Apply the basic knowledge of signals to identify systems properties on causality, stability memory, linearity, and time invariance..
	1.1.2	Apply the knowledge of Continuous time system and discrete time system by performing Convolution in LTI system and with properties of impulse response, to solve problems
	1.1.3	Apply the concepts of z-transforms, to solve Electrical Engineering Problems.
	1.1.4	Apply the basic concepts of Fourier series and properties of Fourier series in CTFS signals,. to solve Electrical Engineering Problems.
	1.1.5	Apply the basic concepts of Fourier series and properties of Fourier series in CTFT signals,. to solve Electrical Engineering Problems

Example: 1.2.3: Represents program outcome '1' , competency '2' , & performance indicator '3' .

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.

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

21UMA303C	Computation Techniques for Electrical Systems -I	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	10 Hrs.
Introduction: Definitions of signals and systems, Classification of signals, Elementary signals, Basic operations on signals, Properties of systems.	
UNIT – II	**10 Hrs.**
Time-domain representation for LTI systems: Convolution, Impulse response representation, Properties of impulse response representation, Block diagram representations	
UNIT – III	**10 Hrs.**
Z-Transforms: Introduction, Z transform, Properties of ROC, Properties of the Z - transform, Inverse Z - transform, Partial fraction expansion method, Transfer function, Causality and Stability	
UNIT – IV	**10 Hrs.**
Fourier Analysis of Continuous Time Periodic and Aperiodic signals: Introduction, Properties of continuous-time Fourier series (Excluding derivation of defining equations for CTFS), Linearity, Time shift, Frequency shift, Scaling, Differentiation and Integration, Convolution and Modulation, Parseval's theorem and problems on properties of Fourier series and Fourier transform.	

References:

1. Simon Haykin and Bary Vam Veen, "Signals and Systems," John Wiely and Sons, 2nd Edition, 2014.
2. H P HSU, "Signals and Systems," Schaums Outline, TMH, 2nd Edition, 2011.
3. Michael Roberts, "Fundamentals of Signals & Systems", 2nd Edition, Tata McGraw-Hill, 2010
4. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia / PHI, 2nd Edition, 2013.
5. Ganesh Rao, Satish Tunga, "Signals and Systems", Sanguine Technical Publishers, 2nd Edition, 2020.

Course Outcomes	Programme Outcomes											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	2	3	--	--	--	--	--	--	--	--	--	1
CO2	3	1	2	1	--	--	--	--	--	--	--	1
CO3	3	3	1	1	--	--	--	--	--	--	--	1
CO4	3	3	2	2	--	--	--	--	--	--	--	1
CO5	3	3	2	2	--	--	--	--	--	--	--	1

Unit Learning Outcomes (ULO): Unit-I

Introduction to Signals and sytems **L-10Hours**

Unit Learning Outcome (ULO)	CO	BLL	PI
1. Students will be able to articulate the definitions of signals and systems, distinguishing between continuous-time and discrete-time signals.	CO1	L1,L2	1.1.1
2. Able to demonstrate an understanding of signal classification, including deterministic and random signals, as well as energy and power signals.	CO1	L1, L3	1.1.1
3. Students will be proficient in recognizing and working with elementary signals, such as unit step, unit impulse, and sinusoidal signals.	CO1	L2,L3	1.1.1
4. able to express complex signals as combinations of elementary signals and apply basic operations, including scaling, time-shifting, and time-reversal.	CO1	L2,L3	1.1.1
5. Students will acquire the skills to perform fundamental operations on signals, including addition, multiplication, and convolution	CO1	L1,L2,L3	1.1.1
6. Able to demonstrate the ability to analyze and manipulate signals mathematically and graphically, using convolution to model system responses to input signals.	CO1	L2,L3	1.1.1
7. Students will gain a comprehensive understanding of the properties of systems, encompassing linearity, time-invariance, causality, and stability.	CO1	L2	1.1.1
8. able to interpret and predict the behavior of systems in real-world applications, fostering a practical understanding of signals and systems.	CO1	L2,L3	1.1.1

Course Content: Unit-I

L-10Hours

Hours Required	Topic to be covered	Mode of Delivery
01	Introduction to Signals and Systems	Chalk and talk in classroom
01	Classification of signals	Chalk and talk in classroom
01	Even and odd signals	Chalk and talk in classroom
01	Continuous and discrete time signals	Chalk and talk in classroom
01	Periodic and Aperiodic signals	Chalk and talk in classroom
01	Energy and Power signals	Chalk and talk in classroom
01	Deterministic and random signals	Chalk and talk in classroom
01	Basic operations on signals	Chalk and talk in classroom
01	Operations on continuous time and discrete time signals	Chalk and talk in classroom
01	Properties of systems.	Chalk and talk in classroom

Review Questions: Unit-I

Review Questions		BLL	PI addressed
1.	Define signal and systems	L1	1.1.1
2.	Definecontinuous and discrete time signals and classify them.	L1	1.1.1
3.	Find the odd and even components of the signal: cost + sin t + cost sin t.	L3	1.1.1
4.	Find odd and even components of x[n] = {1, 2, 2, 3, 4 }.	L1	1.1.1
5.	Find the energy of the signal x[n] = (1/2)n u[n]	L1	1.1.1
6.	Determine whether the signal given below are power or energy signals.Justify your answer $x(t) = Ae^{-2t}u(t)$	L1	1.1.1
7.	Determine whether the signal are periodic.If periodic find its fundamental period. $x(n) = \sin(\frac{3\pi n}{4})\sin(\frac{\pi n}{3})$	L1	1.1.1
8.	Find the even and odd parts of x(t),where $x(t) = \begin{cases} Ae^{-at} & ,t > 0 \\ 0\ , & t < 0 \end{cases}$	L1	1.1.1
9.	Find whether the signal is power or energy signal.$x(t) = e^{j(\frac{5\pi}{6}t)}$	L1	1.1.1
10.	sketch and Label continuous time signal x(t-2).	L1	1.1.1
11.	Sketch and Label the discrete time signals x(2n)	L2	1.1.1
12.	Define energy and power signal and Find the energy of the signal e-2t u(t).	L1 L3	1.1.1
13.	Define unit pulse function.	L2	1.1.1
14.	Define continuous time complex exponential signal.	L2	1.1.1
15	What is continuous time real exponential signal.		1.1.1
16	Explain the difference between continuous-time and discrete-time signals. Provide examples of each and discuss their practical applications	L2	1.1.1
17	Describe the characteristics of unit impulse and unit step signals. How are these signals used in practical scenarios?	L2	1.1.1
18	Discuss the convolution operation in the context of signals and systems. Provide a step-by-step explanation of the convolution process and its significance.	L2	1.1.1
19	Explain linearity and time-invariance properties of systems. How do these properties impact the analysis and design of systems?	L2	1.1.1
20	Represent the multiplication of two signals mathematically. Discuss the significance of this operation in the context of signal processing.	L2	1.1.1
21	Define a causal system and explain its importance in real-world applications. Provide an example of a causal system and discuss its implications.	L2	1.1.1
22	Differentiate between signal energy and signal power. Provide formulas for calculating energy and power for continuous-time and discrete-time signals.	L3	1.1.1
23	Discuss the concept of system stability. How is stability related to the poles of the system transfer function? Provide an example to illustrate stable and unstable systems.	L2	1.1.1
24	Explain the process of signal sampling and its relevance in the context of digital signal processing. Discuss the Nyquist theorem and its implications.	L2	1.1.1
25	Define the frequency response of a system. How does it relate to the system's transfer function? Explain how frequency response analysis is useful in system characterization.	L2	1.1.1

Unit Learning Outcomes (ULO): Unit-II

LTI systems. L-10Hours

Unit Learning Outcome (ULO)	CO	BLL	PI addressed
1. Identify and distinguish LTI systems in the time domain.	CO2	L1,L2	1.1.2
2. Apply convolution to compute the output of a system given its input and impulse response.	CO2	L3	1.1.2
3. Investigate the properties of impulse response representation, such as linearity and time-invariance.	CO2	L3	1.1.2
4. Utilize visualization tools to represent and analyze LTI systems in both time and block diagram domains.	CO2	L2,L3	1.1.2
5. Demonstrate the ability to derive and manipulate mathematical expressions for LTI systems.	CO2	L3	1.1.2
6. Evaluate the impact of different system parameters on the overall behavior of LTI systems.	CO2	L3	1.1.2

Course Content: Unit-II

L-10Hours

Hours Required	Topic to be covered	Mode of Delivery
01	Overview of signals and systems,Classification of signals (continuous-time, discrete-time) and Introduction to LTI systems.	Chalk and talk in classroom
01	Review of continuous-time and discrete-time signals; Mathematical representation of signalsSignal operations: addition, scaling, time shifting	Chalk and talk in classroom
01	Characteristics of systems ,Input-output relationships System properties: linearity, time-invariance.	Chalk and talk in classroom
01	Definition and significance of convolution Convolution integral (continuous-time) and sum (discretetime)Geometrical interpretation of convolution	Chalk and talk in classroom
01	Convolution integral and its application Convolution properties and theorems	Chalk and talk in classroom
01	Convolution sum and its application Properties and theorems related to discrete-timeconvolution.	Chalk and talk in classroom
01	Introduction to impulse response ,Convolution with impulseResponse,Relation between impulse response and systemResponse,	Chalk and talk in classroom
01	Causality and stability of systems,Invertibility and uniqueness of impulse responseStability and instability criteria.	Chalk and talk in classroom
01	N Basics of block diagrams, Block diagram reduction Techniques,Representation of systems using block	Chalk and talk in classroom

	diagrams.	
01	Practical applications of signals and systems, Review of key concepts covered in the course ,Q&A and discussion on advanced topics.	Chalk and talk in classroom

Review Questions: Unit-II

1.	Showthatifx(n)isinputofalineartimeinvariantsystemhavingimpulse responseh(n),then the output of the systemdue tox(n)is$^{y(n)}$x(k)h(nk)		L2	1.1.2
2.	Usethedefinitionofconvolutionsumtoprovethefollowingpropertie s x(n)*[h(n)+g(n)]=x(n)*h(n)+x(n)*g(n)(DistributiveProperty) x(n)*[h(n)*g(n)]=x(n)*h(n)*g(n)(AssociativeProperty) x(n)*h(n)=h(n)*x(n)(CommutativeProperty) Provethatabsolutesummabilityoftheimpulseresponseis anecessaryconditionforstability ofadiscretetimesystem.		L1	1.1.2
3.	Computetheconvolutiony(t)=x(t)*h(t)ofthefollowingpairofsignals: (a) $x(t)=\begin{cases}1 & -a<t\le a\\ 0 & \text{otherwise}\end{cases}$, $h(t)=\begin{cases}1 & -a<t\le a\\ 0 & \text{otherwise}\end{cases}$ (b) $x(t)=\begin{cases}t & 0<t\le T\\ 0 & \text{otherwise}\end{cases}$, $h(t)=\begin{cases}1 & 0<t\le 2T\\ 0 & \text{otherwise}\end{cases}$ (c) $x(t)=u(t-1), h(t)=e^{-3t}u(t)$		L2	1.1.2
4.	Computetheconvolutionsumy[n]=x[n]*h[n]ofthefollowingpairsof sequences: (a) $x[n]=u[n], h[n]=2^n u[-n]$ (b) $x[n]=u[n]-u[n-N], h[n]=\alpha^n u[n], 0<\alpha<1$ (c) $x[n]=(\frac{1}{2})^n u[n], h[n]=\delta[n]-\frac{1}{2}\delta[n-1]$		L2	1.1.2
5.	$y'(t)=x'(t)*h(t)=x(t)*h'(t)$ Showthatify(t)=x(t)*h(t),then		L3	1.1.2
6.	Let***y[n]***=***x[n]*h[n].***Thenshowthat $x[n-n_1]*h[n-n_2]=y[n-n_1-n_2]$		L3	1.1.2
7.	Showthat $x_1[n]\otimes x_2[n]=\sum_{k=n_0}^{n_0+N-1} x_1[k]x_2[n-k]$ foranarbitrarystartingpoint***no.***		L3	1.1.2

Unit Learning Outcomes (ULO): Unit-III

L-10Hours

	Unit Learning Outcome (ULO)	CO	BLL	PI addressed
1.	Apply the properties of Z-transform to analyze and manipulate signals in the Z-domain.	CO3	L1,L3	1.1.3
2.	Apply the inverse Z-transform in practical scenarios, emphasizing its importance in signal reconstruction.	CO3	L2,L3	1.1.3
3.	Solve complex Z-transform expressions using partial fraction decomposition techniques.	CO3	L2,L3	1.1.3
4.	Relate the theoretical concepts learned in this module to practical scenarios in engineering and signal processing.	CO3	L2,L3	1.1.3
5.	Analyze and evaluate different methods and approaches for solving problems related to Z-transforms	CO3	L3	1.1.3
6.	Solve practical problems involving Z-transforms, ROC, inverse Z-transform, partial fraction expansion, transfer functions, causality, and stability.	CO4	L2,L3	1.1.3

L-10Hours

Hours Required	Topic to be covered	Mode of Delivery
01	Importance of signals and systems in various applications	Chalk and talk in classroom
01	Overview of Z-Transforms,Discrete-time signals andsequences ,Z-Transform as a tool for analyzing discrete-time systems.	Chalk and talk in classroom
01	Understanding the Region of Convergence (ROC) Significance in Z-Transform analysis ,Implications on system behavior	Chalk and talk in classroom
01	Essential properties of Z-Transform ,Linearity, time shifting, time scaling, and modulation ,Properties ,Application of these properties in signal analysis	Chalk and talk in classroom
01	Methods for finding the inverse Z-Transform Application of inverse Z-Transform in system analysis Examples and practical exercises	Chalk and talk in classroom
01	Introduction to partial fraction expansion Application in decomposing rational functions Utilization in Z-Transform analysis	Chalk and talk in classroom
01	Definition and significance of transfer function Relationship between Z-Transform and transfer function Application in system analysis and design	Chalk and talk in classroom
01	Understanding causality in the context of signals and SystemsImplications on system behavior and analysis Practical examples demonstrating causal and non-causal systems	Chalk and talk in classroom
01	Definition and importance of stability Analyzing stability using Z-Transform Connection between stability and system response	Chalk and talk in classroom
01	Practical applications of Z-Transform in real-world scenarios Review of key concepts from the previous lectures	Chalk and talk in classroom

	Q&A session and problem-solving exercises	

Review Questions: Unit-III

Integral Calculus.

Review Questions		BLL	PI addressed
1.	Explain the concept of the Z-transform and how it differs from other transforms, such as the Laplace transform.	L1	1.1.3
2.	Compare and contrast the properties of the region of convergence (ROC) with respect to the Z-transform and the Laplace transform.	L1	1.1.3
3.	How do the properties of the Z-transform differ when dealing with discrete-time signals compared to continuous-time signals?	L1	1.1.3
4.	Given a complex signal in the Z-domain, demonstrate how to determine the region of convergence (ROC) and justify its stability.	L1	1.1.3
5.	Apply the partial fraction expansion method to find the inverse Z-transform of a rational function and explain the steps involved.	L3	1.1.3
6.	Design a digital filter using the Z-transform approach, considering causality and stability constraints.	L3	1.1.3
7.	Critically evaluate the implications of choosing different regions of convergence for a Z-transform, particularly in terms of system stability.	L3	1.1.2
8.	Analyze the factors that determine the stability of a discrete-time system based on its Z-transform and transfer function.	L3	1.1.3
9.	Evaluate the advantages and limitations of using the Z-transform in comparison to other signal analysis techniques.	L1	1.1.3
9.	Develop a step-by-step procedure for finding the transfer function of a system using the Z-transform method.	L1	1.1.3
10.	Create a flowchart or diagram illustrating the process of applying the inverse Z-transform using the partial fraction expansion method.	L1	1.1.3
11.	Devise a set of guidelines for determining the causality and stability of a discrete-time system based on its Z-transform representation.	L3	1.1.3

Unit Learning Outcomes (ULO): Unit-IV

L-10 Hours

Unit Learning Outcome (ULO)	CO	BLL	PI
1. Apply the concepts of linearity, time shift, frequency shift, scaling, differentiation, and integration in the context of Fourier series.	CO4	L1,L2,L3	1.1.4
2. Apply time shift, frequency shift, scaling, differentiation, and integration transformations to continuous-time signals	CO4	L2,L3	1.1.4
3. Understand the impact of these transformations on the frequency content and time-domain representation of signals	CO4	L1,L3	1.1.4
4. Apply Parseval's theorem to analyze and solve problems related to the properties of Fourier series and Fourier transform.	CO4	L2	1.1.4
5. Apply mathematical concepts and techniques to analyze and interpret signals in the frequency domain.	CO4	L3	1.1.4
6. Apply acquired skills to analyze and design systems involving continuous-time signals.	CO4	L3	1.1.4

Course Content: Unit-IV

L-10Hours

Hours Required	Topic to be covered	Mode of Delivery
01	Introduction to Fourier Analysis	Chalk and talk in classroom
01	Properties of Continuous-Time Fourier Series (CTFS)	Chalk and talk in classroom
01	Linearity in Fourier Analysis	Chalk and talk in classroom
01	Time Shift in Fourier Analysis	Chalk and talk in classroom
01	Frequency Shift in Fourier Analysis	Chalk and talk in classroom
01	Scaling in Fourier Analysis	Chalk and talk in classroom
01	Differentiation and Integration in Fourier Analysis	Chalk and talk in classroom
01	Convolution and Modulation in Fourier Analysis	Chalk and talk in classroom
01	Parseval’s Theorem in Fourier Analysis	Chalk and talk in classroom
01	Problem Solving Session on Properties of Fourier Series and Transform	Chalk and talk in classroom

Review Questions: Unit-IV

Vector Calculus.

	Review Questions	ULO	BLL	PI addressed
1.	Explain the significance of Parseval's theorem in the context of Fourier analysis.	1	L1	1.1.4
2.	Describe a real-world scenario where Parseval's theorem can be applied to analyze signals.	1	L2	1.1.4
3.	Given a continuous-time periodic signal x(t), apply the properties of Fourier series to find its frequency-shifted version.	1	L2	1.1.4
4.	A sinusoidal signal x(t) = A*sin(2πf0t) is given. Apply Fourier series properties to find the representation of x(t - τ), where τ is a time shift.	1	L3	1.1.4
5.	Compare and contrast the properties of continuous-time Fourier series and Fourier transform. How are they similar, and in what ways do they differ?	2	L3	1.1.4
6.	Analyze the effects of scaling on a signal in the frequency domain using Fourier transform. Provide mathematical expressions and graphical representations.	2	L2	1.1.4
7.	Given two signals x1(t) and x2(t), synthesize a new signal y(t) by convolving x1(t) with a modulated version of x2(t). Discuss the steps involved and interpret the results.	2	L2	1.1.4
8.	Synthesize a periodic signal using Fourier series that exhibits both time and frequency shifts. Explain the steps involved in the synthesis process.	2	L3	1.1.4

9.	Evaluate the impact of differentiation on the frequency content of a signal in the Fourier domain. How does the derivative operation affect the spectral characteristics?	2	L2	1.1.4
10.	Given a signal x(t) with its Fourier transform X(f), evaluate the Fourier transform of its derivative dx/dt in terms of X(f) and interpret the results.	3	L3	1.1.4
11.	Given a continuous-time signal x(t) with its Fourier Transform X(f), perform time and frequency shifts on x(t) and find the resulting signals and their corresponding Fourier Transforms.	3	L3	1.1.4
12.	Given two continuous-time signals x1(t) and x2(t) with their Fourier Transforms X1(f) and X2(f), prove the linearity property of the Fourier Transform. Also, find the convolution of x1(t) and x2(t) and determine its Fourier Transform.	4	L2	1.1.4
13.	Consider a continuous-time signal x(t), and perform scaling operations and differentiation on x(t). Find the Fourier Transforms of the scaled and differentiated signals and compare them with the original signal's Fourier Transform.	4	L3	1.1.4
14.	Given a message signal m(t) and a carrier signal c(t), perform amplitude modulation to obtain the modulated signal s(t). Then, demodulate s(t) and analyze the Fourier Transforms at each step.	5	L3	1.1.4
15.	Given a continuous-time signal x(t) with its Fourier Transform X(f), apply Parseval's theorem to relate the energy of x(t) in the time domain to the energy of X(f) in the frequency domain.	6	L3	1.1.4
		6	L3	1.1.4

Details of Assignment:

Pattern for Assignment 1:

1. Number of problems can be draw from unit-I and unit-II
2. Students should use acquired knowledge to solve assignment problems.
3. Based on acquired knowledge, assignment test1 will be conducted for 5 marks.

Pattern for Assignment 2:

1. Number of problems can be draw from unit-III and unit-IV
2. Students should use acquired knowledge to solve assignment problems.
3. Based on acquired knowledge, assignment test2 will be conducted for 5 marks.

Assignment	Questions		CO	PI	PO
	1	Define a signal and a system in the context of signal processing.	1	1.1.1	1
	2	Classify signals based on their characteristics. Provide examples for each class.	1	1.1.1	1
	3	Explain the difference between continuous-time and discrete-time signals. Give an example of each	1	1.1.1	1
	4	Define and express the unit step function (u(t)) as a mathematical equation.	1	1.1.1	1
	5	Describe the unit impulse function (delta(t)), and explain its significance in signal processing.	1	1.1.1	1
	6	Express the unit ramp function (r(t)) mathematically and provide its graphical representation.	1	1.1.1	1
	7	Explain the concept of signal addition. Provide mathematical expressions for adding two signals, x(t) and y(t).	2	1.1.2	1
	8	Discuss signal multiplication. If x(t)=2*exp[-3t]and y(t)=u(t) find the product signal z(t)=x(t) y(t)	2	1.1.2	1

Assignment 1	9	Define signal scaling and time shifting. If x(t)=sin(2*pi*t), find y(t) if y(t)=x(2t-1)	2	1.1.2	1
	10	State and explain the linearity property of systems. Provide an example of a linear system.	2	1.1.2	1
	11	Define time-invariance. If y(t)=x(2t-1), determine if the system is time-invariant.	2	1.1.2	1
	12	Discuss the causality property of systems. Explain why a causal system is essential in real-world applications.	2	1.1.2	1
	13	Consider a system with the input x(t)=exp[-t]. If the output is y(t)=3*exp[-2t], determine the system's response to x(t)=u(t).	2	1.1.2	1
Assignment 2	1	Consider a periodic signal x(t) with period T and Fourier series representation x(f). Determine the Fourier series representation of the following signals: (i) 2x(t) (ii)X(t-2)	3	1.1.3	1
	2	Given two signals (i) x1(t=cos(2pi*f1*t) and (ii)x2(t)= sin(2pi*f2*t), find the Fourier series representation of the linear combination y(t)=3*x1(t)+2*x2(t). Also, find y(f), the Fourier transform of y(t).	3	1.1.3	1
	3	For a continuous-time signal x(t)=cos(2*pi*f0*t), find the Fourier series representation of the frequency-shifted and time-scaled signal y(t)=x(2t-1) cos()2*pi*f1*t). Determine y(f), the Fourier transform of y(t)	3	1.1.3	1
	4	Given a signal x(t)=exp[-at]*u(t), where u(t) is the unit step function, find the Fourier transform x(f). Determine the Fourier transform of the differentiated signal y(t)= $\frac{d}{dt}x(t)$and the integrated signal $z(t)=\int_{-\infty}^{t} x(t)dt$.	3	1.1.3	1
	5	Consider two signalsx1(t) = cos(2πf1t)and x2(t) = $e^{-at}u(t)$, where u(t) is the unit step function. Compute the convolution y(t)=x1(t)*x2(t) and the modulated signal z(t)=x1(t).x2(t). Determine their Fourier transforms y(f) and z(f) respectively.	3	1.1.3	1
	6	Define the Z-Transform. Explain its significance in signal processing.	3	1.1.3	1
	7	Discuss the key differences between the Z-Transform and Laplace Transform.	3	1.1.3	1
	8	Define the Region of Convergence (ROC) for a Z-Transform. Why is it important?	3	1.1.3	1
	9	Explain how the ROC is related to the convergence of the Z-Transform.	3	1.1.3	1
	10	State and prove the linearity property of the Z-Transform.	4	1.1.4	1
	11	Discuss the time shifting property of the Z-Transform and provide an example.	4	1.1.4	1
	12	Explain the concept of the inverse Z-Transform.	4	1.1.4	1
	13	Given a Z-Transform, demonstrate the steps to find its inverse Z-Transform.	4	1.1.4	1
	14	Discuss the partial fraction expansion method for finding inverse Z-Transforms.	4	1.1.4	1
	15	Provide an example where partial fraction expansion is applied to a Z-Transform.	4	1.1.4	1
	16	Define the transfer function in the context of Z-Transforms.	4	1.1.4	1
	17	Discuss the significance of transfer functions in control systems.	4	1.1.4	1

	18	Given a rational Z-Transform, apply the partial fraction expansion method to find its inverse Z-Transform.	4	1.1.4	1
	19	Discuss the implications of causality and stability on the system described by the given Z-Transform.	4	1.1.4	1
	20	Analyze the stability of a system represented by a Z-Transform and determine the region of convergence.	4	1.1.4	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**

Question paper pattern for CIE-I and CIE-II:

1. Question paper consists Part-A and Part-B. Part A Question number 1 is compulsory, it consists of short answer questions of 1 or 2 marks, covering Unit-I/III and Unit-II/IV
2. In Part-B, three questions are to be set as per the following table.

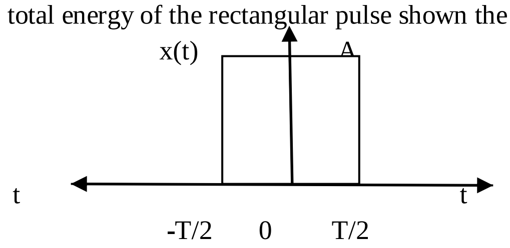
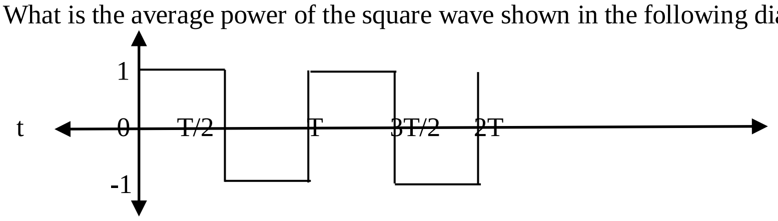
CIE	Number of questions / Maximum marks	Sub divisions	Covering entire unit
I	One question of 15 marks.	Sub divisions shall not be mixed within the unit	Unit I
	One question of 15 marks.	Sub divisions shall not be mixed within the unit	Unit-I
	One question of 15 marks.	Sub divisions shall not be mixed within the unit	Unit-II
	One question of 15 marks.	Sub divisions shall not be mixed within the unit	Unit-II
II	One question of 15 marks	Sub divisions shall not be mixed within the unit	Unit-III
	One question of 15 marks	Sub divisions shall not be mixed within the unit	Unit-III
	One question of 15 marks	Sub divisions shall not be mixed within the unit	Unit-IV
	One question of 15 marks	Sub divisions shall not be mixed within the unit	Unit-IV

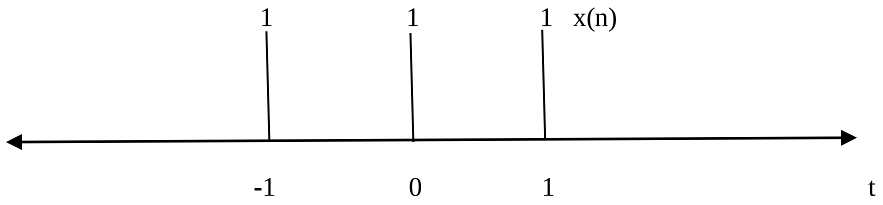
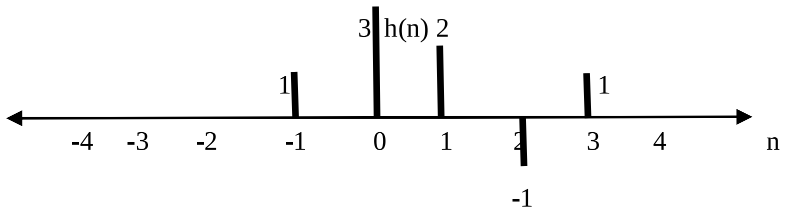
Question paper pattern for SEE:

1. Question paper consists Part-A and Part-B. Question number 1 is compulsory, it consists of short answer questions of 1 or 2 marks, covering entire syllabus.
2. In Part-B total of eight questions with two from each unit; with internal choice to be set uniformly covering the entire syllabus.
3. Each question carries 20 marks and should not have more than four subdivisions.
4. In Part-B, any FOUR full questions are to be answered choosing at least one from each unit.
5. Sketches, figures and tables if any should be clearly drawn, as the same is scanned for printing.
6. The question paper should contain all the data / figures / marks allocated, with clarity.

SEE Model question paper

Course	**B.E**	**Semester**	**III**
Subject	**Computation Techniques for Electrical System-I**	**Branch**	**EEE**
Subject Code	**22UMA303C**	**Max. Marks**	**100**
Duration	$1\frac{1}{2}$ hours		

Q. No.	**Question**	**MARKS**	**BL**	**CO**	**PI**
	Note: PART-A: All questions are compulsory **PART –B: Answer any ONE full question selecting at least from each unit.**				
1. i	What is a signal	2	L1	1	1.1.1
ii.	Define periodic signal	2	L1	1	1.1.1
iii.	Define Unit Step function	2	L1	2	1.1.2
iv.	Define Convolution	2	L1	2	1.1.2
v.	Define Impulse function	2	L1	2	1.1.2
vi	Find the z-transform of $(1/2)^{-n}\ u(-n-1)$	2	L2	3	1.1.3
vii	Find the z-transform of $(1/3)^{-n}\ u(-n-1)$	2	L2	3	1.1.3
viii	Define linearity property in Fourier series	2	L1	4	1.1.4
ix	Define time scaling property in Fourier series	2	L1	4	1.14
x	Define Modulation property in Fourier Transform.	2	L1	4	1.1.4
	Unit-I				
2a	Find the even and odd components of (i) $x(t) = e^{jt}$.(ii)x(n)={1,2,2,3} for n=0,1,2,3	6	L3	1	1.1.1
b	What is the total energy of the rectangular pulse shown the following figure 	7	L3	1	1.1.1
c	What is the average power of the square wave shown in the following diagram 	7	L3	1	1.1.1
3. a.	Show that the product of two even signals or two odd signals is even signal while the product of an even and odd signal is an odd signal.	6	L3	2	1.1.2
b.	Find the even and odd components of the following signal	7	L3	2	1.1.2

	x(t) = Cost + sint + cost sint				
c.	What is the total energy of the discrete time signal x(n) shown in the following diagram 	7	L3	2	1.1.2
	Unit-II				
4. a.	Given x(t) = $t^2 + 2t + 1$ and y(t) = $t^2 + 3t + 4$, Calculate convolution of x(t) and y(t).	6	L3	2	1.1.1
b.	Write the properties of Convolution	7	L2	2	1.1.1
c.	Evaluate the following integrals $i)\int_{-3}^{\infty}(t+1)\delta(t)$ $ii\int_{-3}^{-5}(t^2+1)\delta(t)$ $iii)\int_{-\infty}^{-3}e^{-at}u(t)$ $iv)\int_{-\infty}^{\infty}e^{2t}\delta(t-2)$	7	L3	2	1.1.2
5a	A discrete time LTI system has impulse response h(n) as shown in the following figure. Using linearity and time invariance property determine the system output y(n) if the input x(n) is given by x(n) = 2 δ(n) - δ(n -1). 	6	L3	2	1.1.2
b	A continuous time LTI system is represented by the impulse response, h(t) = e^{-3t} u(t-1) . Determine whether it is i) Stable ii) Causal.	7	L3	2	1.1.2
c	Find the natural response for the system described by the differential equation $5\frac{dy(t)}{dt}+10y(t)=2x(t); \quad y(0)=3.$	7	L3	2	1.1.2
	Unit-III				
Q.6a)	Find the z-transform of x(n) = a^n u(n) and plot the region of convergence.	6	L3	3	1.1.3
b)	Find the Z-transform of the sequence x(n) = a^{-n} u(-n-1)	7	L3	3	1.1.3
c)	For a signal x(n) = 7 $(1/3)^n$ u(n) – 6 $(½)^n$ u(n), find the z-transform and region of	7	L3	3	1.1.3

	convergence.				
Q.7a)	If $Z(x(n)) = X(z)$ then prove that $Z(n - n_0) = z^{-n_0} X(z)$.	6	L3	3	1.1.3
b)	Find the initial value of the z-transform of a anti causal system $X(z) = \frac{3-4z}{1-2z+5z^2}$	7	L3	3	1.1.3
c)	Find the inverse z-transform of $H(z) = \frac{z^2+2z}{z^2-3z+2}$	7	L3	3	1.1.3
	Unit-IV				
Q.8a)	Find Cn for the signal given below $x(t) = 3 + 2\sin\omega_0 t + \cos\omega_0 t + \cos(2\omega_0 t + \pi/4)$	6	L3	4	1.1.4
b)	Sketch the magnitude and phase Spectra of $x(t) = 10\cos 2\pi(5)t + 8\sin 2\pi(10)t - 4\cos 2\pi(20)t$	7	L3	4	1.1.4
c)	Evaluate the Fourier series representation for the signal $x(t) = \sin(2\pi t) + \cos(3\pi t)$	7	L3	4	1.1.4
Q.9a)	Obtain the Fourier transform of the signal $x(t) = e^{-at}u(t)$; $a > 0$. Draw its magnitude and phase Spectra.	6	L3	4	1.1.4
b)	Find the Fourier transform of the signum function i.e $x(t) = sgn(t)$.	7	L3	4	1.1.4
c)	Determine the time-domain signal corresponding to the following Fourier transform $X(j\omega) = e^{-2\omega}u(\omega)$.	7	L3	4	1.1.4

BASAVESHWAR ENGINEERING COLLEGE(AUTONOMOUS), BAGALKOT

MODEL COURSE PLAN

Title of Course	:	Network Analysis	Course Code	:	22UEE305C
Credits	:	03 (2:1:0)	Contact Hours/ Week	:	04hrs/Week
Total Hours	:	52	Tutorial Hours	:	26
CIE Marks	:	50	SEE Marks	:	50
Semester	:	IV	Year	:	2023-24(Odd)

Prerequisites: Basic and advanced mathematics

Course Objectives:

Objective: To analyze the electrical circuit behaviour in time and frequency domains.

Course Outcomes:

	At the end of the course the student should be able to:
1	Calculate current, voltage and power dissipated in various branches of the complex electric circuit having three or more meshes/nodes by applying electric circuit theorems.
2	Solve and analyze the electrical circuits under circuits under transient conditions with the given initial conditions using Laplace transforms.
3	Analyze series and parallel resonance circuits to determine the circuit parameters (L&C) for which the circuit will resonate at given frequency.
4	Evaluate Admittance, Impedance, Hybrid and Transmission parameters for a given two port network by driving the relation between different set of parameters.

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

Sl. No.	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	22UEE305C.1	3							1		1		1	3	1	1
2	22UEE305C.2	3	1						1		1		1	2	3	1
3	22UEE305C.3	3	3	2	2	1			1		1		1	1	1	1
4	22UEE305C.4	3	3	3	3	1			1	1	1		1	1	1	1

Competencies Addressed in the course and Corresponding Performance Indicators

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

	Competency		Indicators
1.1	**Demonstrate the competence in solving engineering mathematical problems**	1.1.1	Apply fundamentals of mathematics to solve problems.
		1.1.2	Apply advanced mathematical techniques to modelling and problem solving in electrical engineering.
		1.4.1	Apply discipline specific laws and principles to solve an engineering problem.
1.2	**Demonstrate the competence in basic sciences**	1.2.1	Apply laws of natural science to an engineering problem.
1.3	**Demonstrate the competence in engineering fundamentals**	1.3.1	Apply elements of electrical engineering principles and laws.
2.1	**Demonstrate an ability to identify and characterize an engineering problem**	2.1.2	Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem.
2.4	**Demonstrate an ability to execute a solution, process and analyse results**	2.4.1	Apply engineering mathematics and computations to solve mathematical models.
3.1	**Demonstrate an ability to define a complex open-ended problem in engineering terms**	3.1.1	Recognize that good problem definition assists in design process.
4.1	**Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding**	4.1.2	Relate modern engineering experimentation including experiment design, system calibration, data acquisition, analysis and presentation.
5.1	**Demonstrate an ability to identify/create modern engineering tools, techniques and resources.**	5.1.1	Identify modern engineering tools, techniques and resources for engineering activities.
5.2	**Demonstrate an ability to select and apply discipline specific tools, techniques and resources.**	5.2.2	Demonstrate proficiency in using computing, mathematical, circuit simulation, and document presentation/preparation software. (MATLAB/Scilab, PSPICE, and others).

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.

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:

Sl.No.	Hours Required	Topic to be covered	Mode of Delivery
		Unit-I	
1	**1L**	**Practical source transformation**	**Chalk and talk in classroom/Lecture combined with discussions**
2	**1L**	**Star delta transformation**	
3	1T	Numerical problems on practical source transformation	
4	1T	Numerical problems on star delta transformation	
5	**1L**	**Loop analysis, concept of super mesh.**	
6	**1L**	**Node analysis, concept of super node**	
7	1T	Numerical problems on loop analysis	
8	1T	Numerical problems on node analysis	
9	**1L**	**Graph of network, tree, co-tree, incidence matrix**	
10	**1L**	**Tie-set & Cut-set schedule**	
11	1T	Numerical problems on Tie-set	
12	1T	Numerical problems on Cut-set	
13	**1L**	**Formation of equilibrium equations, principle of duality**	
14	1T	Numerical problems on formation of equilibrium equations	
15	1T	Numerical problems on principle of duality	
		Unit-II	
16	**1L**	**Superposition theorem**	**Chalk and talk in classroom/Lecture combined with discussions**
17	**1L**	**Thevenin's theorem, Norton's theorem**	
18	1T	Exercises on Superposition theorem	
19	1T	Exercises on Thevenin's theorem, Norton's theorem	
20	**1L**	**Maximum power transfer theorem**	
21	**1L**	**Reciprocity theorem**	
22	1T	Exercises on Maximum power transfer theorem	
23	1T	Exercises on Reciprocity theorem	
24	**1L**	Millman's theorem	
25	**1L**	Compensation theorem,Tellegan's theorem.	
26	1T	Exercises on Millman's theorem	
27	1T	Exercises on Compensation theorem,Tellegan's theorem.	
		Unit-III	
28	**1L**	Initial and final conditions of elements	**Chalk and talk in classroom/Lecture combined with discussions**
29	**1L**	Evaluation of Initial and final conditions in RL, RC circuits.	
30	1T	Exercises on evaluation of Initial and final conditions in RL circuits.	
31	1T	Exercises on evaluation of Initial and final conditions in RC circuits.	
32	**1L**	**Evaluation of Initial and final conditions in RLC circuits.**	
33	**1L**	**Step, ramp, and impulse functions and their Laplace transformation**	
34	1T	Exercises on evaluation of Initial and final conditions in RLC circuits.	

35	1T	Exercises on step, ramp, and impulse functions and their Laplace transformation.	
36	**1L**	**Waveform synthesis and Laplace transformation**	
37	**1L**	**Initial value and final value theorem**	
38	1T	Exercises on waveform synthesis and Laplace transformation.	
39	1T	Exercises on initial value and final value theorem.	
40	**1L**	**Transformed network and their solution**	
		Unit-IV	
41	**1L**	**Series resonance circuit**	**Chalk and talk in classroom/Lecture combined with discussions**
42	**1L**	**Parallel resonance circuit, Q-factor, Bandwidth**	
43	1T	Exercises on series resonance circuit.	
44	1T	Exercises on parallel resonance circuit.	
45	**1L**	**Short circuit admittance parameters.**	
46	**1L**	**Open circuit impedance parameters.**	
47	1T	Exercises on short circuit admittance parameters	
48	1T	Exercises on open circuit impedance parameters.	
49	**1L**	**Transmission parameters**	
50	**1L**	**Hybrid parameters, Relationship between parameters sets**	
51	1T	Exercises on transmission parameters.	
52	1T	Exercises on hybrid parameters.	

Review Questions:

Sr.No.	**Review Questions**		**BLL**	**PI addressed**
1	What is meant by electrical network?		**1**	**1.4.1**
2	Distinguish between voltage source and current source.		**2**	**1.4.1**
3	State superposition theorem.		**1**	**1.4.1**
4	Define tree and co-tree.		**1**	**1.4.1**
5	What is principle of duality?		**2**	**1.4.1**
6	What is condition of maximum power transfer?		**1**	**1.4.1**
7	What are limitations of reciprocity theorem?		**1**	**1.4.1**
8	What is Thevenin’s theorem?.		**1**	**1.4.1**
9	What are initial conditions? .		**1**	**2.1.2**
10	How does inductor behave during initial conditions?		**2**	**1.4.1**
11	Why do we need Laplace transform?		**1**	**1.4.1**
12	Obtain the Laplace transform of step, ramp and impulse functions.		**2**	**2.1.2**
13	State initial value theorem.		**1**	**1.4.1**
14	State final value theorem.		**2**	**1.4.1**
15	Define bandwidth of a resonant circuit.		**2**	**1.4.1**
16	Define Q-factor.		**01**	**1.4.1**
17	What is the purpose of two-port network??		**01**	**1.4.1**
18	Define h-parameters with regard to two-port network.		**01**	**1.4.1**
19	Define input driving point impedance.		**02**	**1.4.1**
20	Why ABCD parameters are also called as transmission parameters?		**02**	**1.4.1**

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 Quiz:

Assignment Quiz	Marks (10)	CO	PI	CA	PO
		1,2,3,4	1.4.1, 2.1.2	1.1,2.1, 2.2, 2.4	1,2,3,4

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT

COURSE PLAN

Title of Course	**:**	**Electronic Circuits**	**Course Code**	**:**	**UEE306C**
Credits	**:**	**03**	**Contact Hours/ Week**	**:**	**03**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**-**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**III**	**Academic Year**	**:**	**2023-24**

Prerequisites: Basic concept of diodes, transistors, FETs, and other electronic components. Basic concept of KVL, and KCL.

Course Objectives:

	The Course objectives are:
1	To impart the knowledge on rectifiers, clippers, and clampers. To understand the transistor dc circuits.
2	To solve the problems on rectifiers, clippers, clampers and transistor amplifiers
3	To design the necessary diode or transistor circuit based on the given specifications
4	To understand and analyse the op-amp characteristics and applications

Course Outcomes:

	At the end of the course the student should be able to:
1	Design and analyze diode clipping, limiting and clamping circuits
2	Examine various transistor biasing circuits
3	Analyse BJT, MOSFETs, and multistage amplifiers
4	Design and analyse op-amp based feedback circuits and various applications of op amps

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

S.No	**Programme Outcomes / Course Outcomes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	Design and analyze diode clipping, limiting and clamping circuits	**3**	**2**	**2**									**2**	**3**	**3**	**3**
2	Examine various transistor biasing circuits	**3**	**2**										**2**	**2**	**3**	**3**
3	Analyse BJT, MOSFETs, and multistage amplifiers	**3**		**3**		**1**			**1**		**1**		**1**	**2**	**2**	**1**
4	Design and analyse op-amp based feedback circuits and various applications of op amp**s**	**3**	**3**	**3**		**1**			**1**		**1**		**2**	**2**	**2**	**1**

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL
	Unit -I		
1.	Students shall be able to understand the importance of the diode applications	**1**	**1**
2.	Students shall be able to understand the significance of the components of a diode circuits	**1**	**1**
3.	Students shall be able to define/describe the terms such as rectifiers, clipping, clamping	**1**	**2**
4.	Students shall be able to draw the operating point for the transistor biasing	**1**	**3**
5.	Students shall be able to apply dc circuit analysis for the transistor biasing	**1**	**3**
6.	Students shall be able to solve numerical on rectifiers, clipping and clamping circuits	**3**	**4**
7.	Students shall be able to understand the concept bias stability of a transistor circuits	**1**	**2**
8.	Students shall be able to construct/design the circuit for the given situation of clipping and clamping circuits	**3**	**3**
9.	Students shall be able to derive the equation for the stability factor for the transistor amplifier	**3**	**3**
10.	Students shall be able to solve the numerical on transistor biasing	**4**	**4**
	Unit -II		
11.	Students shall be able to understand the concept of two port network	**1**	**1**
12.	Students shall be able to classify types of two port network	**2**	**2**
13.	Students shall be able to understand the concept of hybrid model of a transistor	**1**	**2**
14.	Students shall be able to develop hybrid model for CE configuration of the transistor	**4**	**4**
15.	Students shall be able to analyse the CE configuration of the transistor amplifier in hybrid model	**4**	**3**
16.	Students shall be able to understand the concept of multistage amplifiers	**1**	**1**
17.	Students shall be able to classify the amplifiers based on their output signal	**3**	**4**
18.	Students shall be able to understand the transfer characteristics of an FET	**1**	**1**
19.	Students shall be able to understand the important relations in an FET	**1**	**1**
20.	Students shall be able to solve the numerical on FET amplifiers	**4**	**4**
	Unit-III		
21.	Students shall be able to understand the concept of op-amp	**2**	**2**
22.	Students shall be able to define the characteristics of an op-amp	**1**	**1**
23.	Students shall be able to formulate the gain equation for inverting, non-inverting amplifier	**2**	**3**
24.	Students shall be able to understand the op-amp as integrator and differentiator	**3**	**3**
25.	Students shall be able to understand and solve the problems on precision half wave & full wave rectifiers	**4**	**4**
26.	Students shall be able to understand and solve the problems on limiting circuits, clamping circuits, peak detectors, sample and hold circuits		
27.	Students shall be able to understand and solve the problems on voltage regulators basics, voltage follower regulator, adjustable output regulator	**4**	**4**
	Unit-IV		
28.	Students shall be able to understand definition and concept of op-amp applications such as Zero crossing detectors, inverting Schmitt trigger circuit, non- inverting Schmitt circuit	**4**	**1**

29.	Students shall be able to understand role of astable multivibrator and mono-stable multivibrator using 555 timer	**4**	**2**
30.	Students shall be able to derive an equation for the output signal for Phase shift oscillator, oscillator amplitude stabilization and Wein bridge oscillator and solve problems	**4**	**3**
31.	Students shall be able to understand and define first and second order high pass and low pass filters, band stop and band pass filters and solve problems	**4**	**4**

Programme Outcomes with Respective Competencies & Performance Indicators

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

	Competency	PI	Indicators
1.1	**Demonstrate the competence in solving engineering mathematical problems**	**1.1.1**	**Apply fundamentals of mathematics to solve problems**
		1.1.2	**Apply advanced mathematical techniques to modelling and problem solving in electrical engineering**
1.2	**Demonstrate the competence in basic sciences**	**1.2.1**	**Apply laws of natural science to an engineering problem**
1.3	**Demonstrate competence in engineering fundamentals**	**1.3.1**	**Apply elements of electrical engineering principles and laws**
1.4	**Demonstrate competence in Electrical engineering knowledge**	**1.4.1**	**Apply discipline specific laws and principles to solve an engineering problem**

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

	Competency	PI	Indicators
2.1	**Demonstrate an ability to identify and characterize an engineering problem**	**2.1.1**	**Evaluate problem statements and Identify objectives**
		2.1.2	**Identify engineering systems, variables, and parameters to solve the problems**
		2.1.3	**Identify the mathematical, engineering and other relevant knowledge that applies to a given problem**
2.2	**Demonstrate an ability to formulate a solution plan and methodology for an engineering problem**	**2.2.1**	**Reframe complex problems into interconnected sub-problems.**
		2.2.2	**Identify, assemble and evaluate information and resources.**
		2.2.3	**Identify existing processes/solution methods for solving the problem, including justified approximations and assumptions**
		2.2.4	**Compare and contrast alternative solution processes to select the best process.**
2.3	**Demonstrate an ability to formulate and interpret a system / model**	**2.3.1**	**Combine scientific and engineering principles to formulate models (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.**
		2.3.2	**Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.**
2.4	**Demonstrate an ability to execute a solution, process and analyse results**	**2.4.1**	**Apply engineering mathematics and computations to solve (form & analyse) mathematical models.**
		2.4.2	**Produce and validate results through skilful use of contemporary engineering tools and models**
		2.4.3	**Identify sources of error in the solution process, and limitations of the solution.**
		2.4.4	**Extract desired understanding and conclusions consistent with objectives and limitations of the analysis**

PO3: Design/Development of Solutions: **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 public health and safety, and cultural, societal, and environmental considerations.**

	Competency	PI	Indicators
3.1	Demonstrate an ability to define a complex open-ended problem in engineering terms	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 a review of the State of the Art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards
		3.1.5	Explore and synthesize engineering requirements from larger social and professional concerns
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	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 formal multi-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	Demonstrate an ability to advance an engineering design to defined end state	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generates information through appropriate tests to improve, or revise design states

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.

	Competency	PI	Indicators
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem for purpose of investigation, its scope and 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	Establish or validate a relationship between measured data and underlying physical principles.
4.2	Demonstrate an ability to design experiments to solve open ended problems	4.2.1	Develop and design experimental approach, specify appropriate equipment and procedures, implement these procedures, and interpret the resulting data to characterise an engineering material, component, or system.
		4.2.2	Understand the importance of statistical design of experiments and choose an appropriate experimental design plan based on the study objectives
4.3	Demonstrate an ability to critically analyze data to reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to collect and analyse data
		4.3.2	Critically analyse 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: 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.

	Competency	PI	Indicators
5.1	Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
		5.1.2	Create / adapt / modify / extend tools and techniques to solve problems
5.2	Demonstrate an ability to select and apply discipline specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulation, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using computing, mathematical, circuit simulation, and document presentation/preparation software. (MATLAB / Scilab, PSPICE, SABER, PROTEUS software tools, AutoCAD, project management tools, Latex and others)
5.3	Demonstrate an ability to evaluate the suitability and limitations of the tools used to solve an engineering problem	5.3.1	Identify limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

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.**

	Competency	PI	Indicators
6.1	Demonstrate the ability to describe engineering roles in a broader context, e.g. as pertains to the environment, health, safety, and public welfare	6.1.1	Identify and describe various engineering roles particularly pertaining to protection of the public and public interest
6.1	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to electrical and electronics engineering discipline (such as IEEE) and explain its contribution to the protection of the public

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.**

	Competency	PI	Indicators
7.1	Demonstrate an understanding of the impact of engineering and industrial practice on social, environmental and economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Demonstrate an understanding of the relationship betweenthe technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevantto Electrical and Electronics Engineering

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

	Competency	PI	Indicators
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of the IEEE professional code of ethics
		8.2.2	Examine and apply moral & ethical principles to historically famous case studies

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

	Competency	PI	Indicators
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity in a team
		9.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual & team operations -- communication, problem solving, resolution & leadership skills	9.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
9.3	Demonstrate success in a team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the 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

	Competency	PI	Indicators
10.1	Demonstrate an ability to comprehend technical literature and document project work.	10.1.1	Read, understand and interpret technical and non-technical information
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents
		10.1.3	Create *flow* in a document or presentation – a logical progression of ideas so that the main point is clear
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and view point of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation

PO 11: 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.

	Competency	PI	Indicators
11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2	Demonstrate and ability to Compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.2	Analyze and select the most appropriate proposal based on economic and financial considerations.
11.3	Demonstrate an ability to plan/manage an engineering activity withintime and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project so as to complete on time and within budget.

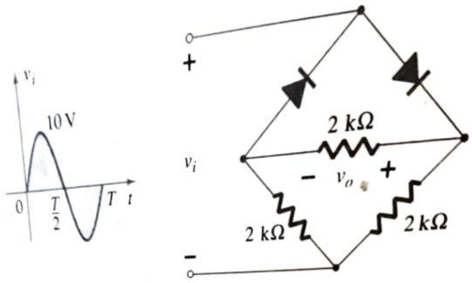
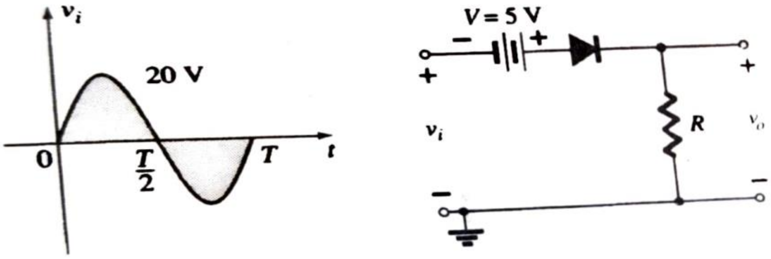
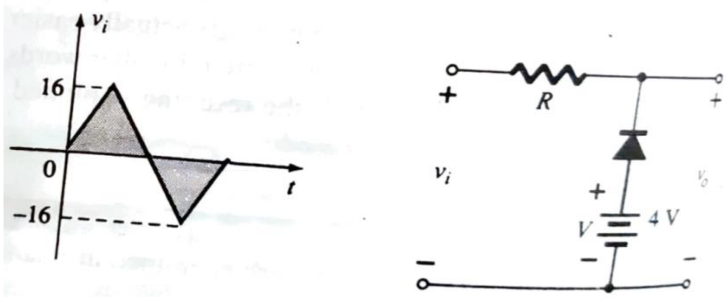
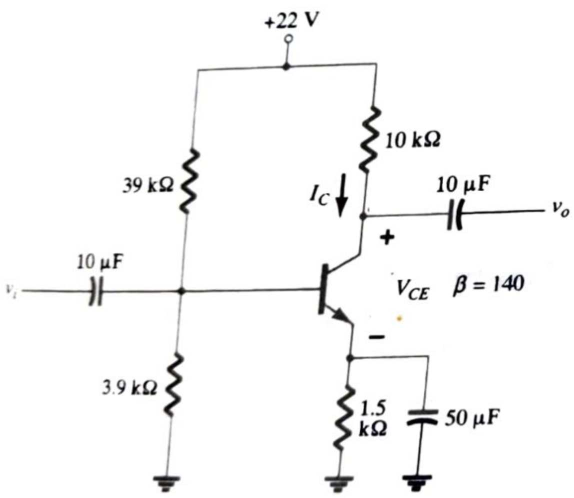
PO12: Life-long learning: Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
	Competency	**PI**	**Indicators**
12.1	**Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps**	**12.1.1**	**Describe the rationale behind the requirement for continuing professional development**
		12.1.2	**Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to bridge the same**
12.2	**Demonstrate an ability to Identify changing trends in engineering knowledge and practice**	**12.2.1**	**Identify historic points of technological advance in engineering that require practitioners to seek education in order to stay updated**
		12.2.2	**Recognize the need and be able to clearly explain why it is vitally important to keep updated regarding new developments in the field**
12.3	**Demonstrate an ability to identify and access sources for new information**	**12.3.1**	**Demonstrate an ability to source and comprehend technical literature and other credible sources of information**

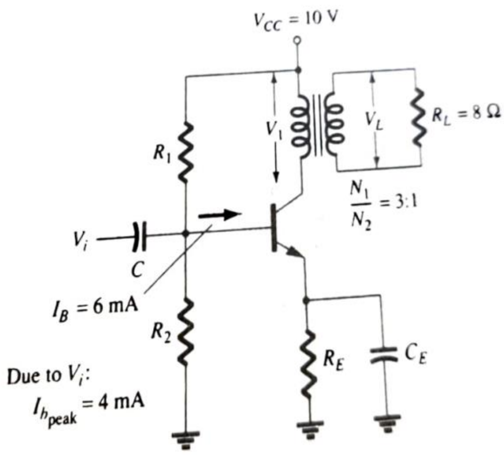
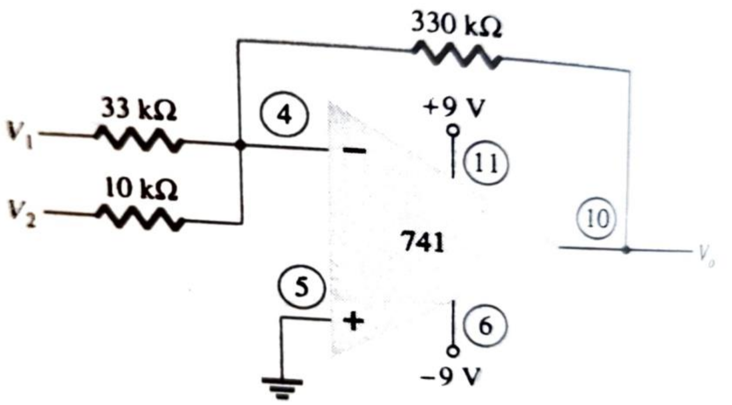
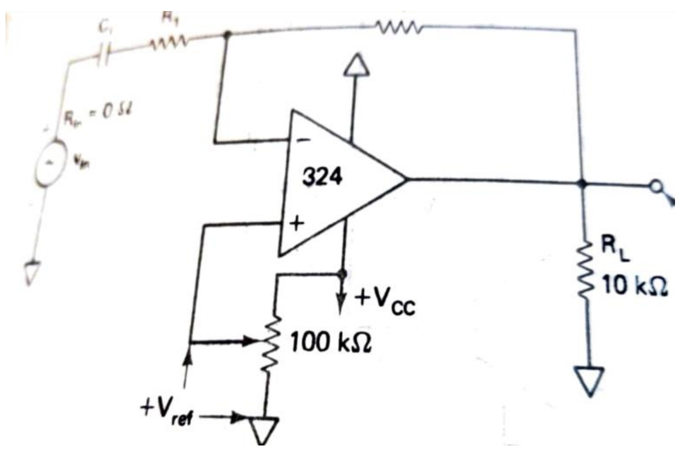
Course Content:

Day	Content	Mode of Delivery
1	**Diode Circuits:** Introduction	Chalk and talk in classroom
2	Clipping circuits	
3	Clipping at two independent levels	
4	ClampingCircuits	
5	Comparators	
6	Full wave rectifier with C filter	
7	**Transistor Biasing:** Introduction	
8	Operating point, DC load line	
9	Bias stability, voltage divider bias	
10	Derivation of stability factors, Bias compensation	
11	**BJT Low Frequency Analysis:** Introduction, two port devices.	Chalk and talk in classroom
12	Hybrid model, transistor hybrid model.	
13	h - Parameters, Analysis of transistor amplifier circuit using h- parameters (CE amplifier only)	
14	**Multistage Amplifiers & Power Amplifier:** Introduction, Classification of Amplifiers	
15	Frequency response of R-C coupled amplifier	
16	Class A large signals amplifier	
17	Transformer coupled power amplifier, Class B (Push pull) amplifiers	
18	**Field Effect Transistor:** Transfer characteristics of JFET, Important relationships	
19	Depletion & Enhancement type MOSFETs	
20	Assignment on Unit 1 and 2	
21	**Basics of Op-Amps:** Block diagram and characteristics of 741 Op-amp	

22	Op-amp as an inverting and non- inverting amplifier	Hybrid
23	Voltage follower, adder	
24	Subtractor	
25	Integrator and differentiator	
26	**Signal Processing circuits:** Precision half wave & full wave rectifiers	
27	Limiting circuits, clamping circuits	
28	Peak detectors, sample and hold circuits	
29	Voltage regulators basics, voltage follower regulator	
30	Adjustable output regulator	
31	**Applications of Op-Amps:** Zero crossing detectors	Hybrid
32	Inverting Schmitt trigger circuit, non- inverting Schmitt circuit.	
33	Astable multivibrator and mono-stable multivibrator using 555 timer	
34	Phase shift oscillator, oscillator amplitude stabilization	
35	Wein bridge oscillator	
36	**Active filters:** First order high pass and low pass filters	
37	Second order high pass and low pass filters	
38	Band stop filters	
39	Band pass filters	
40	Assignment on Unit 3 and 4	

Review Questions:

Sl.	Review Questions	CO	BLL	PI
1	Determine the output waveform for the following network and calculate the output dc level and the required PIV of each diode 	01	L3	2.1.2
2	Determine the output waveform for the sinusoidal input 	01	L4	2.1.3
3	Determine V_0 for the given network 	01	L3	2.4.1
4	Determine the dc bias voltage V_{CE} and the current I_C for the voltage divider bias configuration 	02	L3	1.3.1
5	Differentiate between depletion type MOSFET and enhancement type MOSFET	03	L4	1.3.1

6	Given β = 120, I_E = 3.2 mA for a common emitter configuration with $r_0 = \infty$ Ω, determine: Z_i, A_v if a load of 2 k Ω is applied, A_v with the 2 k Ω load	01	L2	1.2.1
7	Calculate the ac power delivered to the 8 Ω speaker for the following circuit. The circuit component values result in a dc base current of 6 mA, and the input signal results in a peak base current swing of 4 mA. 	04	L4	2.1.3
8	For a Class B amplifier using a supply of Vcc = 30 V and driving a load of 16 Ω, determine the maximum input power, output power and transistor dissipation	03	L3	2.1.3
9	Calculate the output voltage for the following circuit. The inputs are V1 = 50mV sin (1000t) and V2 = 10 mV sin (3000t). 	04	L3	2.1.2
10	Design a differentiator to differentiate an input signal that varies in frequency from 10 Hz to 1 kHz. If a sine wave of 1 V peak at 1000 Hz is applied to the circuit, draw its output waveform	04	L3	2.1.3
11	Analyse the following op-amp circuit and draw the output waveform 	04	L3	2.1.3
12	Monostable multivibrator is to be used as a divide by 2 neywork. The frequency of the input trigger signal is 2 kHz. If the value of C = 0.01µF, what should be the value of R_A?	04	L3	2.1.1

13	Design an RC phase shift oscillator to generate a frequency of 200 Hz.	04	L3	2.1.1
14	Design a low pass filter at a cut off frequency of 1 k Hz with a passband gain of 2.	04	L3	1.4.1
15	Design a high pass filter at a cut off frequency of 1 k Hz with a passband gain of 2. Also plot the frequency response of the filter	04	L3	2.3.1

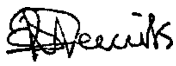
Evaluation Scheme:

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
Problem solving on Unit I	2.5	01	1.1.1 1.4.1	1.1 1.4	1
Problem solving on Unit II	2.5	02	1.6.1	1.6	1
Quiz	2.5	03, 04	2.1.2	2.1	2
Quiz	2.5	03, 04	2.1.3	2.1	2

Dr. Chayalakshmi C. L.



Head of the Department
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BASAVESHWAR ENGINEERING COLLEGE(AUTONOMOUS), BAGALKOT

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE PLAN

Title of Course	**:**	**Electrical Machines-I**	**Course Code**	**:**	**UEE307C**
Credits	**:**	**03**	**Contact Hours/ Week**	**:**	**03**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**-**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**III**	**Year**	**:**	**2023**

Prerequisites: Fundamental electrical concepts, including Ohm's Law, Kirchhoff's Laws, basic circuit analysis, and DC circuits. understanding of concepts like magnetic fields, Faraday's Law, Ampere's Law, and inductance. Proficiency in analysing AC circuits, phasor analysis, and understanding of complex impedance. Basic physics knowledge, especially in the areas of mechanics and thermodynamics, may be beneficial for understanding the physical principles underlying electrical machines.

Course Objectives:

	The Course objectives are:
1	To impart the knowledge of construction and working principle of a single-phase transformer. To derive the EMF equation for a single-phase transformer. To draw phasor diagrams for various operating conditions of a single-phase transformer and calculate the equivalent circuit parameters of a single-phase transformer using open-circuit and short-circuit tests. To understand the concept of per unit (p.u.) scaling and its application in transformer analysis and calculate losses and efficiency of a single-phase transformer, including all-day efficiency. To determine the voltage regulation of a single-phase transformer using various methods and perform polarity test and Sumpner's test on a single-phase transformer.
2	To impart the knowledge of construction and types of three-phase transformers. To analyze the operation of banks of single-phase transformers used for three-phase operation. To learn about different three-phase transformer connections: star-star, star-delta, delta-star, delta-delta, open delta, and their applications. To understand the concept of labeling terminals and vector groups in three-phase transformers and to explain the principle of single-unit three-phase transformers. To analyze the effect of harmonics on three-phase transformers and methods for their suppression, including the use of tertiary windings. To understand Scott connection and its application in phase conversion. To understand the conditions required for parallel operation of three-phase transformers and analyze load sharing between them. To learn about the construction, working principle, and applications of auto transformers.
3	To impart the knowledge of construction and types of three-phase induction motors and the principle of operation of a three-phase induction motor, including the production of rotating magnetic field. To define slip and explain its role in the operation of an induction motor and analyze the rotor induced emf and its frequency. To calculate power losses in an induction motor and understand their impact on efficiency. To draw and interpret the equivalent circuit of a three-phase induction motor. To derive the torque equation for an induction motor and analyze its torque-slip characteristics in motoring, generating, and braking modes. To calculate starting torque and maximum torque of an induction motor and understand the effect of rotor resistance on torque-slip characteristics.
4	To provide the knowledge of using starters for starting three-phase induction motors. To Analyze the operation of different types of starters, including direct-on-line (DOL), star-delta, autotransformer, and rotor resistance starters. To Calculate the starting torque of an induction motor using various methods. To learn about double cage and deep bar motors and their advantages. To Analyze various methods for speed control of three-phase induction motors, including rotor resistance control, voltage control, and V/f control. To understand the NEMA classifications of three-phase induction motors.

Course Outcomes:

	At the end of the course the student should be able to:
1	Test the given transformers and induction motors by various methods and predetermine their performance such as losses, efficiency, and regulation.
2	Connect the given transformers in different configurations for different operations, like autotransformer, parallel operation and 3-phase connections.
3	Control the starting current and speed of 3-phase induction motors by suitable methods.
4	Select suitable induction motors for different industrial or domestic applications.

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

S.No	Programme Outcomes / Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	UEE307C.1	3	2	1	-	-	-	-	-	-	1	-	1	3	2	-
2	UEE307C.2	2	2	3	1	1	1	-	-	-	1	-	-	1	2	1
3	UEE307C.3	3	3	2	1	1	-	-	-	-	-	-	1	1	2	1
4	UEE307C.4	3	3	2	1	2	-	-	-	-	-	1	1	1	2	1

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL
	Unit –I		
1.	Students shall be able to understand and describe the key components and constructional details of single-phase transformers.	2	2
2.	Students shall be able to derive the electromagnetic force (EMF) equation for a single-phase transformer based on its construction.	1	3
3.	Students shall be able to create and interpret phasor diagrams to visualize the relationships between voltage and current in single-phase transformers.	1	6
4.	Students shall be able to apply Open Circuit (OC) and Short Circuit (SC) tests to calculate the equivalent circuit parameters of a single-phase transformer.	2	3
5.	Students shall be able to determine transformer ratings based on design specifications and constraints.	1	5
6.	Students shall be able to apply the concept of per unit (p.u.) scaling for consistent analysis and comparison.	1	3
7.	Students shall be able to analyze and quantify losses, both core and copper losses, in a single-phase transformer.	1	4
8.	Students shall be able to evaluate efficiency, all-day efficiency, and voltage regulation to understand the transformer's performance under different operating conditions.	1	5
9.	Students shall be able to perform polarity tests to determine the correct connection of windings in a transformer.	1	2
10.	Students shall be able to conduct Sumpner's test for assessing the thermal performance and cooling characteristics of a transformer.	2	3
	Unit –II		
11.	Students shall be able to explain the construction principles and various types of three-phase transformers.	1	2

12.	Students shall be able to understand the configurations for connecting single-phase transformers to form a three-phase bank.	**2**	**2**
13.	Students shall be able to implement various connections such as star-star, star-delta, delta-star, delta-delta, and open delta.	**2**	**3**
14.	Students shall be able to label transformer terminals and identify vector groups for different three-phase transformer connections.	**2**	**2**
15.	Students shall be able to analyze harmonics in three-phase transformers.	**1**	**4**
16.	Students shall be able to implement harmonic suppression techniques, including the use of tertiary windings, Scott connections, and phase conversion.	**1**	**3**
17.	Students shall be able to understand the need for parallel operation of transformers in power systems.	**2**	**2**
18.	Students shall be able to identify and articulate the conditions that must be satisfied for transformers to operate in parallel successfully.	**1**	**4**
19.	Students shall be able to understand the principles and factors governing load sharing among parallel transformers.	**2**	**2**
20.	Students shall be able to explain the construction and working principles of auto transformers.	**1**	**2**
21.	Students shall be able to understand the advantages of auto transformers in terms of copper saving.	**2**	**2**
22.	Students shall be able to identify and describe applications where auto transformers are commonly used.	**1**	**4**
	Unit-III		
23.	Students shall be able to describe the constructional features of three-phase induction motors.	**1**	**4**
24.	Students shall be able to differentiate between various types of three-phase induction motors.	**1**	**3**
25.	Students shall be able to understand the principle of operation of three-phase induction motors.	**2**	**2**
26.	Students shall be able to explain the production of a rotating magnetic field and its significance in motor operation.	**1**	**4**
27.	Students shall be able to define and calculate slip in three-phase induction motors.	**1**	**1**
28.	Students shall be able to explain the generation of rotor-induced electromotive force (EMF) and its frequency.	**2**	**3**
29.	Students shall be able to analyze power losses in three-phase induction motors.	**1**	**4**
30.	Students shall be able to develop an understanding of the equivalent circuit of an induction motor.	**1**	**3**
31.	Students shall be able to derive the torque equation for three-phase induction motors	**1**	**3**
32.	Students shall be able to understand torque-slip characteristics in motoring, generating, and braking modes.	**1**	**2**
33.	Students shall be able to calculate and analyze the starting torque of an induction motor.	**1**	**3**
34.	Students shall be able to determine the conditions for achieving maximum torque.	**2**	**3**
35.	Students shall be able to evaluate the impact of rotor resistances on torque-slip characteristics.	**1**	**4**
36.	Students shall be able to calculate and understand the power output of an induction motor.	**1**	**4**
37.	Students shall be able to conduct and interpret the results of no-load and blocked rotor tests for the evaluation of equivalent circuit parameters.	**4**	**5**
38.	Students shall be able to identify and explain the phenomena of cogging and crawling in induction motors.	**4**	**3**
39.	Students shall be able to introduce and understand the use of the circle diagram for analyzing the performance of three-phase induction motors.	**1**	**2**
	Unit-IV		
40.	Students shall be able to understand the necessity for starters in three-phase induction motors and their role in controlling starting conditions.	**3**	**2**
41.	Students shall be able to explain various starting methods, including Direct-On-Line (DOL), star-delta, autotransformer, and rotor resistance starters.	**3**	**3**

42.	Students shall be able to understand the principles behind each starting method.	**1**	**2**
43.	Students shall be able to calculate the starting torque for different starting methods.	**1**	**4**
44.	Students shall be able to evaluate the conditions affecting the starting torque of three-phase induction motors.	**1**	**5**
45.	Students shall be able to understand the construction and operational characteristics of double cage and deep bar induction motors.	**1**	**2**
46.	Students shall be able to analyze the performance of these motors in specific applications.	**1**	**4**
47.	Students shall be able to understand the principles of speed control in three-phase induction motors.	**1**	**2**
48.	Students shall be able to understand speed control techniques using rotor resistance, voltage control, and V/f control.	**3**	**2**
49.	Students shall be able to familiarize with NEMA classifications for three-phase induction motors.	**1**	**1**
50.	Students shall be able to identify and apply appropriate NEMA classifications based on motor characteristics.	**1**	**1**
51.	Students shall be able to introduce and understand the principles of induction generation in electrical systems.	**1**	**2**
52.	Students shall be able to understand the construction and principles of linear induction motors.	**1**	**2**
53.	Students shall be able to analyze the applications and advantages of linear induction motors.	**2**	**4**
54.	Students shall be able to describe the constructional features of single-phase induction motors.	**2**	**2**
55.	Students shall be able to understand the double field revolving theory in single-phase motors.	**1**	**2**
56.	Students shall be able to develop an understanding of the equivalent circuit of single-phase induction motors.	**1**	**2**
57.	Students shall be able to analyze the starting methods for single-phase motors, including resistance split-phase, capacitor start, capacitor run, and shaded pole motors.	**4**	**4**

Programme Outcomes with Respective Competencies & Performance Indicators

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

	Competency	PI	Indicators
1.1	**Demonstrate the competence in solving engineering mathematical problems**	**1.1.1**	**Apply fundamentals of mathematics to solve problems**
		1.1.2	**Apply advanced mathematical techniques to modelling and problem solving in electrical engineering**
1.2	**Demonstrate the competence in basic sciences**	**1.2.1**	**Apply laws of natural science to an engineering problem**
1.3	**Demonstrate competence in engineering fundamentals**	**1.3.1**	**Apply elements of electrical engineering principles and laws**
1.4	**Demonstrate competence in Electrical engineering knowledge**	**1.4.1**	**Apply discipline specific laws and principles to solve an engineering problem**

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

	Competency	PI	Indicators
2.1	Demonstrate an ability to identify and characterize an engineering problem	2.1.1	Evaluate problem statements and Identify objectives
		2.1.2	Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1	Reframe complex problems into interconnected sub-problems.
		2.2.2	Identify, assemble and evaluate information and resources.
		2.2.3	Identify existing processes/solution methods for solving the problem, including justified approximations and assumptions
		2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a system / model	2.3.1	Combine scientific and engineering principles to formulate models (mathematical or otherwise) of a system or process that isappropriate in terms of applicability and required accuracy.
		2.3.2	Identify assumptions (mathematical and physical) necessary to allow modelling of a system at the level of accuracy required.
2.4	Demonstrate an ability to execute a solution, process and analyse results	2.4.1	Apply engineering mathematics and computations to solve (form & analyse) mathematical models.
		2.4.2	Produce and validate results through skilful use of contemporary engineering tools and models
		2.4.3	Identify sources of error in the solution process, and limitations of the solution.
		2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

PO3: Design/Development of Solutions: 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 public health and safety, and cultural, societal, and environmental considerations.

	Competency	PI	Indicators
3.1	Demonstrate an ability to define a complex open-ended problem in engineering terms	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 a review of the State of the Art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards
		3.1.5	Explore and synthesize engineering requirements from larger social and professional concerns
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	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 formal multi-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	Demonstrate an ability to advance an engineering design to defined end state	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generates information through appropriate tests to improve, or revise design states

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.

	Competency	PI	Indicators
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem for purpose of investigation, its scope and 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	Establish or validate a relationship between measured data and underlying physical principles.
4.2	Demonstrate an ability to design experiments to solve open ended problems	4.2.1	Develop and design experimental approach, specify appropriate equipment and procedures, implement these procedures, and interpret the resulting data to characterise an engineering material, component, or system.
		4.2.2	Understand the importance of statistical design of experiments and choose an appropriate experimental design plan based on the study objectives
4.3	Demonstrate an ability to critically analyze data to reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to collect and analyse data
		4.3.2	Critically analyse 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: 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.

	Competency	PI	Indicators
5.1	Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools, techniques and resources for engineering activities
		5.1.2	Create / adapt / modify / extend tools and techniques to solve problems
5.2	Demonstrate an ability to select and apply discipline specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modelling and simulation, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using computing, mathematical, circuit simulation, and document presentation/preparation software. (MATLAB / Scilab, PSPICE, SABER, PROTEUS software tools, AutoCAD, project management tools, Latex and others)
5.3	Demonstrate an ability to evaluate the suitability and limitations of the tools used to solve an engineering problem	5.3.1	Identify limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

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.

	Competency	PI	Indicators
6.1	Demonstrate the ability to describe engineering roles in a broader context, e.g. as pertains to the environment, health, safety, and public welfare	6.1.1	Identify and describe various engineering roles; particularly pertaining to protection of the public and public interest
6.1	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to electrical and electronics engineering discipline (such as IEEE) and explain its contribution to the protection of the public

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.

	Competency	PI	Indicators
7.1	Demonstrate an understanding of the impact of engineering and industrial practice on social, environmental and economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Demonstrate an understanding of the relationship betweenthe technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevantto Electrical and Electronics Engineering

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

	Competency	PI	Indicators
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of the IEEE professional code of ethics
		8.2.2	Examine and apply moral & ethical principles to historically famous case studies

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

	Competency	PI	Indicators
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity in a team
		9.1.2	Implement the norms of practice (e.g. rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual & team operations -- communication, problem solving, resolution & leadership skills	9.2.1	Demonstrate effective communication, problem solving, conflict resolution and leadership skills
9.3	Demonstrate success in a team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the 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			
	Competency	PI	Indicators
10.1	Demonstrate an ability to comprehend technical literature and document project work.	10.1.1	Read, understand and interpret technical and non-technical information
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents
		10.1.3	Create *flow* in a document or presentation – a logical progression of ideas so that the main point is clear
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and view point of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation

PO 11: 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.			
	Competency	PI	Indicators
11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project
11.2	Demonstrate and ability to Compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.2	Analyze and select the most appropriate proposal based on economic and financial considerations.
11.3	Demonstrate an ability to plan/manage an engineering activity withintime and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project so as to complete on time and within budget.

PO12: Life-long learning: Recognise the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
	Competency	**PI**	**Indicators**
12.1	Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1	Describe the rationale behind the requirement for continuing professional development
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to bridge the same
12.2	Demonstrate an ability to Identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that require practitioners to seek education in order to stay updated
		12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep updated regarding new developments in the field
12.3	Demonstrate an ability to identify and access sources for new information	12.3.1	Demonstrate an ability to source and comprehend technical literature and other credible sources of information

Course Content:

Day	Content	Mode of Delivery
1	Brief Introduction of the course, information regarding the course outcome of the course, program specific outcome and program outcome	Power Point Presentation, Chalk and talk in classroom
2	Constructional details of transformer and Ideal Transformer, Dot Convention And Phasor Diagram	
3	Operation Of Ideal Operation With Load Connected, explanation and Modelling of Practical Transformer - I	
4	Rating of Single Phase Transformer: Rated Current And Rated Voltage With Example	
5	Calculation of parameters by OC and SC tests	
6	Concept on Transformer losses and Transformer efficiency	
7	Concept of transformer regulation	
8	Numerical examples on SC and OC tests, findind all day efficiency	
9	Solving numerical problems on transformer regulation	
10	Polarity Test and Sumpner Test	
11	Construction and Advantages of Three-Phase Transformer	Power Point Presentation, Chalk and talk in classroom
12	Adavntages of a Transformer Bank of Three Single Phase Transformer	
13	Three Phase transformer groups, Three- Phase Transformer Connections	
14	DELTA-DELTA, STAR-STAR, DELTA-STAR Connections	
15	STAR-DELTA, OPEN-DELTA Connection, Applcations OPEN-DELTA System	
16	Labeeling of Transformer terminals and vector groups	
17	Harmonic Phenomenon in Three Phase Transformer, Supression of harmonics by tertiary winding	
18	Scott connection and phase connection	
19	Parallel operation of Transformer: Need for paralell operation, conditions to be satisfied for paralell operation and load sharing	
20	Auto Transformer : Construction, working principle, saving of copper and applications	

21	Three Phase Induction motor Construction and types of motors	Power Point Presentation, Chalk and talk in classroom
22	Principle of operation and Production Rotating magnetic field in three phase induction motors	
23	Speed and Slip, Frequency of rotor induced voltage and current	
24	Power loss in an induction motor, Equivalent circuit of induction motor	
25	Torque and its equation of an Induction motor	
26	Torque-slip and torque-speed characteristics	
27	Staring Torque and maximum torque in Induction motor, Generating and braking modes in Induction motor	
28	Power output, Effect of rotor resistance on torque slip- characteristics	
29	No load and blocked rotor test-evaluation of equivalent circuit parameters	
30	Cogging and crawling , Introduction of circle diagram	
32	Need for starters in starting of three phase induction motors	Power Point Presentation
33	Direct-on-Line Starter, Theory of Direct Switching or DoL starting of Induction motor	
34	Start-Delta Starters, Auto transformer and rotor resistance starters	
35	Calculation of starting torque, double cage and deep bar motors	
36	Speed control by rortoe resistance, voltage control, V/f control, NEMA classifications,	
37	Construction of Single Phase Induction motor, Double field revolving theory of Induction machine	
38	Equivalent Circuit of a Single phase, Single winding induction motorbased on two revolving field theory	
39	Starting of single phase motors: Resistance split phase, capacitor start and capacitor run motors, shaded pole motors	
40	Revision of topics	

Review Questions:

Sl.	Review Questions	CO	BLL	PI
1	Give the emf equation of a transformer and define each term	02	L1	1.3.2
2	Draw and explain the full load phasor diagrams of single phase transformer for lagging, leading, and unity power factor loads.	02	L1	1.3.1
3	Starting from the fundamentals, develop the equivalent circuit of a 1- phase transformer referred to primary and explain.	02	L2	2.1.3
4	A 5kVA,500/250 V, 50Hz, 1- phase transformer gave the following readings, O.C Test: 500 V, 1A, 50 W (L.V side open) S.C Test: 25V, 10A, 60W (L.V side shorted) Determine: i) The efficiency on full load, 0.8 lagging p.f. ii) The voltage regulation on full load, 0.8 leading p.f. iii) Draw the equivalent circuit referred to primary & insert all the value in it.	03	L2	3.2.3
5	Write a short note on "All day efficiency of a transformer"	01	L1	1.3.1
6	Define regulation and derive the condition for maximum regulation of transformer	01	L2	1.4.1
7	A 3-phase step down transformer is connected to 6600 volts mains and it takes 10A. Calculate the secondary line voltage, line current and output for the following connections. Delta-Delta Star-Star Star-Delta Delta-Star. Turns ratio/phase is 12. Draw connection diagrams.	04	L3	2.4.1

8	Show that open delta connection of 3- 4 transformer has KVA rating of 58% of that of delta-delta connection.	04	L3	4.1.2
9	Two 110 volts, 1-phase electric furnaces take loads of 500 kW and 800 kW respectively at a power factor of 0.71 lagging and are supplied from V, 3-p. 50 Hz mains through a Scott connected transformer combination. Calculate the currents in the 3-4 lines neglecting transformer losses. 6600	04	L3	4.1.2
10	Two transformers each of 800 kVA are connected in parallel. One has a resistance and reactance of 1% and 4% respectively and the other has resistance and reactance of 1.5% and 6% respectively. Calculate the load chared by each transformer and corresponding power factor when the total load shared is 100 kVA at 0.8 p.f lagging.	03	L3	1.3.1
11	Derive an expression for the currents shared between the 2 transformers connected in parallel supplying a common load when no load voltages of the transformers are unequal.	03	L3	4.1.2
12	What is an auto-transformer? Derive an expression for the saving of copper in an auto-transformer as compared to an equivalent two winding transformer.	03	L3	1.3.1
13	Show that the ratio of mechanical power developed to the rotor copper loss is ((1-s)/(s)) where's' is the slip.	05	L3	1.3.1
14	Derive the equation for torque developed by the three phase induction motor.	05	L3	1.4.1
15	Draw and explain the torque characteristics for 3-phase induction motor covering motoring, generating and braking regions of operation.	05	L2	2.1.4
16	Draw the circle diagram from no load and short circuit test of a 3-0. 14.92 kW, 400V, 6 pole induction motor with the following test data (line values). No load test: 400V, 11A, p.f=0.2. S.C Test: 100V, 25A, p.f=0.4. Rotor copper loss at stand still is half the total copper loss. From the diagram, find i) Line current ii) Slip iii) Efficiency iv) p.f at full load v) Maximum torque.	05	L3	3.4.1
17	With a neat diagram, explain the working of double cage induction motor.	05	L2	1.3.1
18	Explain the phenomena of crawling in a 3-q induction motor.	05	L2	1.3.1
19	With the help of neat circuit diagram explain the working of a star-delta starter to start 3-phase induction motor.	05	L2	1.3.1
20	With the help of neat circuit diagram explain the working of a star-delta starter to start 3-phase induction motor	06	L2	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
Problem solving on transformer EMF equation and finding the efficiency	2.5	01	1.1.2	1.1	1
Numerical problems on induction motors to find slip, efficiency, maximum torque, line current	2.5	02, 03	2.2.2	2.2	2
Surveying of different Induction Motors, writing the application of new technology motors used in present days.	2.5	03,04	2.3.1		6
Quiz	1.5	03, 04	2.3.1	2.3	2
Quiz	1.5	03, 04			

BASAVESHWARENGINEERINGCOLLEGE,BAGALKOT

COURSEPLAN

Title of Course	**:**	**Electrical and Electronic Measurement**	**Course Code**	**:**	**22UEE308C**
Credits	**:**	**02**	**Contact Hours/Week**	**:**	**02**
Total Hours	**:**	**30**	**Tutorial Hours**	**:**	**-**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**III**	**Academic Year**	**:**	**2023-24**

Prerequisites: Basic concept of current, voltage, resistance, capacitance, inductance (mutual/self)units and dimensions

Course Objectives:

	The Course objectives are:
1	To impart the knowledge on AC/DC bridges, Electrical energy/power meters, current/voltage transformers (CT/PT), Ammeters/Voltmeters, different electrical sensors
2	To solve the numerical problems related to objective1
3	To use and experiment an instrument given in objective1
4	To understand and analyse various electrical sensors

CourseOutcomes:

	At the end of the course the student should be able to:
22UEE308C.1	Measure resistance, inductance and capacitance of a given specimen using DC and AC Bridges and validate the results analytically
22UEE308C.2	Measure resistance, inductance and capacitance of a given specimen using DC and AC Bridges and validate the results analytically
22UEE308C.3	Select Shunts and Multipliers, CTs and PTs to extend the range of ammeters and voltmeters
22UEE308C.4	Select sensors and transducers for different electrical based applications

CourseArticulationMatrix:MappingofCourseOutcomes(CO)withProgrammeOutcomes(PO)andProgrammeSpecificOutcomes(PSO)

S.No	**Programme Outcomes / Course Outcomes**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	**22UEE308C.1**	**3**	**2**	**2**									**2**	**3**		**3**
2	**22UEE308C.2**	**3**	**2**										**2**	**3**		**3**
3	**22UEE308C.3**	**3**		**3**		**1**			**1**		**1**		**1**	**3**		**2**
4	**22UEE308C.4**	**3**	**3**	**3**		**1**			**1**		**1**		**2**	**3**	**1**	**3**

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	COs	BLL
Unit-I			
Studentsshallbeableto:			
1.	Understand the concept of electrical bridges for the measurement of resistance	**1**	**1**
2.	Understand the concept of electrical bridges for the measurement of capacitance	**1**	**1**
3.	Understand the concept of electrical bridges for the measurement of inductance (Self/Mutual)	**1**	**1**
4.	Derive equations for unknown resistance/capacitance/inductance for a given bridge	**1**	**2**
5.	Understand various sources and detectors for AC/DC bridges	**1**	**2**
6.	Solve numerical problems on DC bridges	**3**	**3**
7.	Solve numerical problems on AC bridges	**1**	**3**
Unit-II			
Students shall be able to:			
9.	Understand the concept of electrical power and energy and its measurement	**1**	**1**
10.	Derive equation for single phase wattmeters	**2**	**2**
11.	Solve numerical problems on single phase wattmeters	**1**	**2**
12.	Derive equation for single phase energy meter (Electro-dynamometer type)	**4**	**4**
13.	Solve numerical problems on single phase energy meter (Electro-dynamometer type)	**4**	**3**
14.	Understand the construction and use of Weston frequency meter	**1**	**1**
	Unit-III		
Students shall be able to:			
15.	Understand the concept of shunts and multipliers for the extension of ammeter and voltmeters	**2**	**2**
16.	Solve numerical problems on extension of ammeter and voltmeters	**1**	**1**
17.	Understand the concept of CT/PT	**2**	**3**

18.	Derive equation for CT	**3**	**3**
19.	Solve the problems on CT	**4**	**4**
20.	Derive equation for PT		
21.	Solve the problems on PT	**4**	**4**
Unit-IV			
Students shall be able to:			
22.	Understand definition and concept of electrical sensors and their merits	**4**	**1**
23.	Differentiate active and passive transducers	**4**	**2**
24.	Understand the principle, construction and working of few resistive transducers: RTD/LDR	**4**	**3**
25.	Understand the principle, construction and working of parallel plate capacitive transducers	**4**	**4**
26.	Understand the principle, construction and working of inductive transducers: LVDT	**4**	**4**
27.	Understand the principle, construction and working of semiconductor sensor: LM35	**4**	**4**

ProgrammeOutcomeswithRespectiveCompetencies&PerformanceIndicators

PO1:Engineeringknowledge: Applytheknowledgeofmathematics,science,engineeringfundamentals,andanengineeringspecialisation for thesolution ofcomplexengineeringproblems.

	Competency	PI	Indicators
1.1	Demonstrate the competence in solvingengineeringmathematicalproblems	1.1.1	Applyfundamentalsofmathematicstosolveproblems
		1.1.2	Applyadvancedmathematicaltechniquestomodellingandproblemsolvinginelectricalengineering
1.2	Demonstratethecompetenceinbasicsciences	1.2.1	Applylawsofnaturalsciencetoanengineeringproblem
1.3	Demonstrate competence inengineeringfundamentals	1.3.1	Applyelementsofelectricalengineeringprinciplesandlaws
1.4	Demonstrate competence in Electricalengineeringknowledge	1.4.1	Applydisciplinespecificlawsandprinciplestosolveanengineeringproblem

PO2:Problemanalysis: Identify,formulate,researchliterature,andanalysecomplexengineeringproblemsreachingsubstantiatedconclusionsusingfirstprinciplesofmathematics,naturalsciences,andengineering sciences.

	Competency	PI	Indicators
2.1	Demonstrate an abilityto identifyandcharacterizeanengineering problem	2.1.1	EvaluateproblemstatementsandIdentifyobjectives
		2.1.2	Identifyengineeringsystems,variables,andparameterstosolvetheproblems
		2.1.3	Identifythemathematical,engineeringandotherrelevantknowledgethatappliestoagivenproblem
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/solutionmethodsforsolving theproblem,includingjustifiedapproximationsandassumptions
		2.2.4	Compareandcontrast alternativesolutionprocessestoselectthebestprocess.
2.3	Demonstrateanabilitytoformulateandinterpretasystem/model	2.3.1	Combinescientificandengineeringprinciplestoformulate models(mathematicalorotherwise) ofasystemorprocessthatis appropriateintermsofapplicability andrequiredaccuracy.
		2.3.2	Identify assumptions(mathematicalandphysical) necessarytoallowmodellingofasystemattheleveIof accuracyrequired.
2.4	Demonstrateanabilitytoexecuteasolution,processandanalyseresults	2.4.1	Applyengineeringmathematicsandcomputationstosolve (form & analyse) mathematical models.
		2.4.2	Produceandvalidateresultsthroughskilfuluseofcontemporaryengineeringtoolsandmodels
		2.4.3	Identifysourcesoferrorinthesolutionprocess,andlimitationsof thesolution.
		2.4.4	Extractdesiredunderstandingandconclusionsconsistentwithobjectivesandlimitationsoftheanalysis

PO3:Design/Development of Solutions: 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 public health and safety, and cultural, societal, and environmental considerations.

	Competency	PI	Indicators
3.1	Demonstrateanabilitytodefineacomplex open-endedprobleminengineeringterms	3.1.1	Recognize that good problem definition assists in the design process
		3.1.2	Elicit and document engineering requirements from stake holders
		3.1.3	Synthesize engineering requirements from a review of the State of the Art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards
		3.1.5	Explore and synthesize engineering requirements from larger social and professional concerns
		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrateanabilitytogenerateadiverse set of alternative designsolutions	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	Demonstrateanabilitytoselectthe optimal design scheme for furtherdevelopment	3.3.1	Apply formal multi-criteria decision making tools to Select optimal engineering design solutions for further development
		3.3.2	Consult with domain experts and stake holders to select candidate engineering design solution for further development
3.4	Demonstrateanabilitytoadvanceanengineeringdesigntodefinedendstate	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generates information through appropriate tests to improve,or revise design states

PO4:Conductinvestigationsofcomplexproblems: Useresearch-basedknowledgeandresearchmethodsincludingdesignofexperiments,analysisandinterpretationofdata,andsynthesisoftheinformationto providevalidconclusions.

	Competency	PI	Indicators
4.1	Demonstrateanabilitytoconduct investigations of technical issues consistent with their level of knowledgeandunderstanding	4.1.1	Defineaproblemforpurposeofinvestigation,itsscopeand importance
		4.1.2	Relatemodernengineeringexperimentationincludingexperiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Applyappropriateinstrumentation,and/orsoftwaretoolstomake measurementsofphysicalquantities
		4.1.4	Establishorvalidatearelationshipbetween measureddataand underlyingphysicalprinciples.
4.2	Demonstrateanabilitytodesignexperimentstosolveopenendedproblems	4.2.1	Developanddesignexperimentalapproach,specifyappropriateequipmentandprocedures,implementtheseprocedures,and interpret the resulting data to characterise an engineering material,component,orsystem.
		4.2.2	Understandtheimportanceofstatisticaldesignofexperiments and choose an appropriate experimental design plan based on the studyobjectives
4.3	Demonstrateanabilitytocriticallyanalyze data to reach avalid conclusion	4.3.1	Useappropriateprocedures,toolsandtechniques tocollectandanalysedata
		4.3.2	Criticallyanalysedatafortrendsandcorrelations,statingpossibleerrors andlimitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitateanalysisandexplanationof thedata,anddrawconclusions
		4.3.4	Synthesizeinformationandknowledge abouttheproblemfromtherawdatatoreachappropriate conclusions

PO5:Moderntoolusage: Create,select,andapplyappropriatetechniques,resources,andmodernengineeringandITtoolsincludingpredictionandmodellingtocomplexengineeringactivitieswithan understandingofthelimitations.

	Competency	PI	Indicators
5.1	Demonstrateanabilitytoidentify/createmodernengineeringtools,techniques andresources	5.1.1	Identifymodernengineeringtools,techniquesandresourcesforengineeringactivities
		5.1.2	Create/adapt/modify/extendtoolsandtechniquestosolveproblems
5.2	Demonstrate an ability to select andapplydisciplinespecifictools,techniquesand resources	5.2.1	Identifythestrengthsandlimitationsoftoolsfor(i)acquiringinformation,(ii)modellingandsimulation,(iii)monitoringsystem performance,and(iv)creatingengineeringdesigns.
		5.2.2	Demonstrateproficiencyinusingcomputing,mathematical,circuitsimulation,anddocumentpresentation/preparationsoftware.(MATLAB/Scilab,PSPICE,SABER,PROTEUSsoftwaretools, AutoCAD,projectmanagementtools,Latexandothers)
5.3	Demonstrateanabilitytoevaluatethesuitability and limitations of the toolsusedtosolveanengineeringproblem	5.3.1	Identifylimitationsandvalidatetools,techniquesandresources
		5.3.2	Verify the credibility of results from tool use with reference to theaccuracyandlimitations,andtheassumptionsinherentintheiruse.

PO6:Theengineerandsociety: Applyreasoninginformedbythecontextualknowledgetoassesssocietal, health,safety,legalandculturalissuesandtheconsequentresponsibilitiesrelevanttotheprofessionalengineeringpractice.

	Competency	PI	Indicators
6.1	Demonstrate the ability to describe engineeringrolesinabroadercontext,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,legislationandstandards	6.2.1	Interpretlegislation,regulations,codes,andstandardsrelevant to electrical and electronics engineering discipline(suchasIEEE)andexplainitscontributiontotheprotectionof thepublic

PO7:Environmentandsustainability: Understandtheimpactoftheprofessionalengineeringsolutionsin societalandenvironmentalcontexts,anddemonstratetheknowledgeof,andneedforsustainabledevelopment.

	Competency	PI	Indicators
7.1	Demonstrate an understanding of the impactofengineeringandindustrialpracticeonsocial,environmentalandeconomiccontexts	7.1.1	Identifyrisks/impactsinthelife-cycleofanengineering productoractivity
		7.1.2	Demonstrate an understanding of the relationshipbetweenthe technical, socio-economicand environmental dimensionsofsustainability
7.2	Demonstrate an abilityto applyprinciples ofsustainabledesignanddevelopment	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering andsustainable developmenttoanengineeringactivityorproductrelevantto ElectricalandElectronicsEngineering

PO8:Ethics: Applyethicalprinciplesandcommittoprofessionalethics,responsibilitiesandnormsoftheengineering practice.

	Competency	PI	Indicators
8.1	Demonstrateanabilitytorecognizeethicaldilemmas	8.1.1	Identifysituationsofunethicalprofessionalconductandproposeethicalalternatives
8.2	Demonstrate an ability to applytheCodeof Ethics	8.2.1	IdentifytenetsoftheIEEEprofessionalcodeofethics
		8.2.2	Examineandapplymoral&ethicalprinciplestohistoricallyfamouscasestudies

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverseteams,andinmultidisciplinarysettings.

	Competency	PI	Indicators
9.1	Demonstrateanabilityto formateam anddefinea roleforeachmember	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity in a team
		9.1.2	Implement the norms of practice (e.g.rules,roles,charters, agendas,etc.) of effective team work, to accomplish a goal.
9.2	Demonstrateeffectiveindividual&teamoperations -- communication, problem solving,resolution&leadershipskills	9.2.1	Demonstrate effective communication, Problem solving, conflict resolution and leadership skills
9.3	Demonstratesuccessinateam-basedproject	9.3.1	Presentresultsasateam,withsmoothintegrationofcontributionsfromallindividualefforts

PO10:Communication: Communicateeffectivelyoncomplexengineeringactivitieswiththeengineeringcommunityandwiththesocietyatlarge,suchas,beingabletocomprehendandwriteeffectivereportsand designdocumentation,makeeffectivepresentations,andgiveandreceiveclearinstructions

	Competency	PI	Indicators
10.1	Demonstrateanabilitytocomprehendtechnical literature and document projectwork.	10.1.1	Read,understandandinterprettechnicalandnon-technical information
		10.1.2	Produceclear, well-constructed, andwell-supportedwrittenengineeringdocuments
		10.1.3	Create*flow*inadocumentorpresentation–alogical progressionofideassothatthemainpointisclear
10.2	Demonstrate competence in listening,speaking,andpresentation	10.2.1	Listen toand comprehendinformation,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	Useavarietyofmediaeffectivelytoconveyamessageina documentorapresentation

PO11:Projectmanagementandfinance: Demonstrateknowledgeandunderstandingoftheengineeringand managementprinciplesandapply thesetoone'sownwork,asamemberandleaderinateam,tomanageprojectsandinmultidisciplinaryenvironments.

	Competency	PI	Indicators
11.1	Demonstrateanabilitytoevaluatetheeconomic and financial performance of anengineeringactivity	11.1.1	Describevariouseconomicandfinancialcosts/benefitsofanengineeringactivity
		11.1.2	Analyzedifferentformsoffinancialstatementstoevaluatethefinancialstatusof anengineering project
11.2	Demonstrate and ability to Compare andcontrastthecosts/benefitsof alternate proposalsforanengineeringactivity	11.2.2	Analyzeandselectthemostappropriateproposalbasedoneconomicandfinancialconsiderations.
11.3	Demonstrate an ability toplan/manage an engineering activitywithintimeandbudgetconstraints	11.3.1	Identify the tasks required to complete an engineeringactivity,andtheresourcesrequiredtocompletethetasks.
		11.3.2	Useprojectmanagementtoolstoscheduleanengineeringprojectsoastocompleteontimeandwithinbudget.

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 forcontinuingprofessionaldevelopment
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrateanabilitytosourceinformationtobridgethesame
12.2	Demonstrate an ability to Identify changingtrendsinengineeringknowledgeandpractice	12.2.1	Identifyhistoricpointsoftechnologicaladvancein engineeringthatrequirepractitionerstoseekeducationinordertostayupdated
		12.2.2	Recognizetheneedandbeabletoclearlyexplainwhyitis vitallyimportanttokeepupdatedregardingnewdevelopmentsinthefield
12.3	Demonstrateanabilitytoidentifyandaccesssourcesfornewinformation	12.3.1	Demonstrateanabilitytosourceandcomprehend technicalliteratureandothercrediblesourcesofinformation

Course Content:

Class No.	Topic to be covered	Mode of Delivery
Unit-I		
1	Measurement of medium resistance: Wheatstone bridge, Limitations	**Chalk and talk in classroom/Lecture combined with discussions**
2	Solving numerical problems on Wheatstone bridge	
3	Measurement of low resistance: Kelvin's Double bridge; Solving numerical problems	
4	AC Bridges: General equilibrium equations of AC bridges	
5	Measurement of Self Inductance – Types of bridges for measurement of self inductance, Maxwell's Inductance Capacitance Bridge	
6	Measurement of Capacitance: Types of bridges for measurement of capacitance, De Sauty's bridge. Sources of errors in bridge circuits. Sources and Detectors	
7	Solving numerical problems on AC bridges	
Unit-II		
8	Meaning of electrical power and energy in single and three phases	**Chalk and talk in classroom/Lecture combined with discussions**
9	Dynamometer Type Wattmeter; Induction Type Single Phase Energy meter – Construction	
10	Theory of Induction Type Single Phase Energy meter	
11	Dynamometer Type Single Phase Power Factor meter – Construction	
12	Theory of Dynamometer Type Single Phase Power Factor meter	
13	Weston Frequency meter: Construction and working	
Unit-III		
14	Shunts and Multipliers: Use and solving typical problems	**Chalk and talk in classroom/Lecture combined with discussions**
15	Instrument Transformers in extension of range: Advantages of Instrument Transformers	
16	Ratios of Instrument Transformers, Ratio Correction Factor	
17	Burden on Instrument Transformer	
18	Current Transformer (CT) – Theory of CT	
19	Potential Transformer(PT) - Theory of PT	
20	Differences between CT and PT,	
Unit-IV		
21	Definition and Meaning of Sensors and Transducers, Difference between Sensors and Transducers,	**Chalk and talk in classroom/Lecture combined with discussions**
22	Classification (Types) of Transducers: Advantages and Disadvantages of Electrical Transducers	
23	Resistive Transducers - Resistance Temperature Detector (RTD)	
24	Light Dependent Resistor (LDR)	
25	Capacitive Transducers, Inductive Transducers	
26	Linear Variable Differential Transformer (LVDT), LM 35 sensor	

Review Questions:

Sr.No.	Review Questions		BLL	PI addressed
1	What is meant by electrical measurement?		**1**	**1.4.1**
2	Distinguish between DC and AC bridges.		**2**	**1.4.1**
3	Numerical problems on AC/DC bridges		**3**	**1.4.1**
4	Draw a neat diagram to show various elements of a single phase electro-dynamometer wattmeter		**1**	**1.4.1**
5	Draw a neat diagram to show various elements of a single phase electro-dynamometer energy meter		**1**	**1.4.1**
6	Electro-dynamo type wattmeter: Construction and working		**2**	**1.4.1**
7	Electro-dynamo type energy meter: Construction and working		**2**	**1.4.1**
8	Weston frequency meter: Construction and working		**2**	**1.4.1**
9	Extension of ammeter: Typical numerical problems		**2**	**2.1.2**
10	Extension of voltmeter: Typical numerical problems		**2**	**1.4.1**
11	CT: Construction and working		**1**	**1.4.1**
12	PT: Construction and working		**2**	**2.1.2**
13	Practicing phasor diagrams of CT and PT		**1**	**1.4.1**
14	Identification of active and passive transducers in real time applications		**2**	**1.4.1**
15	Constructional details of RTD and LDR		**2**	**1.4.1**
16	Constructional details of typical capacitive transducers		**2**	**1.4.1**
17	Device a method of employing a given resistive/capacitive/inductive transducer for a given practical/real time application Example: Use parallel plate capacitor based on variable distance principle to convert extent of application of brake in a vehicle to proportional capacitance. Design and show the implementation by a pictorial representation		**2**	**1.4.1**
18	Distinguish between active and passive transducers.		**2**	**1.4.1**

Scheme of Evaluation:

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

Details of Assignment:

Assignment	Marks(10)	CO	PI	CA	PO
Class Assignment (Problem Solving)on Unit I	2.0	01	1.1.1 1.4.1	1.1 1.4	1
Class Assignment (Problem solving) on Unit II+III	3.0	02	1.6.1	1.6	1
Assignment on Unit-III + IV	5.0	03,04	2.1.2	2.1	2

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BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT

COURSEPLAN–22UEE315C

Title of Course	**:**	**Sustainable Energy Technologies in Agriculture (Ability Enhancement Course)**	**Course Code**	**:**	**22UEE315C**
Credits	**:**	**3**	**Contact Hours/ Week**	**:**	**3**
Total Hours	**:**	**40**	**Tutorial Hours**	**:**	**--**
CIE Marks	**:**	**50**	**SEE Marks**	**:**	**50**
Semester	**:**	**III**	**Year**	**:**	**2023-2024**

Prerequisites:

Basic information related to agriculture and irrigation systems, Basics of electrical and mechanical engineering, Concept of pumps, Concept of solar photovoltaic systems

Course Objectives:

	The Course objectives are:
1	To understand issues and challenges associated with electrical technologies in irrigation systems
2	To gain knowledge in recent developments in the energy technologies employed for irrigation sector
3	To analyse design procedures of different types of irrigation systems and to achieve energy conservation
4	To identify the energy conservation opportunities in irrigation systems by employing micro irrigation techniques

Course Outcomes:

	At the end of the course the student should be able to:
1	Identify the challenges faced by farmers in irrigation systems and be able to suggest probable solution
2	Assess the optimum size of the irrigation pumps by calculating the exact water requirement of the crops for the specific location for local climatic conditions
3	Analyse the working of solar photovoltaic powered irrigation system under the specified conditions
4	Suggest the type of micro irrigation scheme for specified agriculture land by analysing field conditions

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

Sl.	PO's-PSO's / CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
The students will be able to:																
1	**22UEE315C.1**	**2**	**2**										**1**	**2**		**2**
2	**22UEE315C.2**	**2**	**1**	**1**	**1**		**1**						**1**	**1**		**2**
3	**22UEE315C.3**	**2**	**1**	**1**	**1**		**1**	**1**	**1**				**1**	**1**		**2**
4	**22UEE315C.4**	**2**	**2**	**1**	**1**		**1**	**1**	**1**				**1**	**1**		**1**

Competencies Addressed in the course and Corresponding Performance Indicators

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

PO	Competency		Performance Indicators	
1	1.2	Demonstrate the competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem
	1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply elements of electrical engineering principles and laws
	1.4	Demonstrate competence in Electrical engineering knowledge	1.4.1	Apply discipline specific laws and principles to solve an engineering problem
2	2.1	Demonstrate an ability to identify and characterize an engineering problem	2.1.1	Evaluate problem statements and Identify objectives
	2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.2	Identify, assemble and evaluate information and resources.
			2.2.4	Compare and contrast alternative solution processes to select the best process
3	3.1	Demonstrate an ability to define a complex open-ended problem in engineering terms	3.1.4	Extract engineering requirements from relevant engineering Codes and Standards
			3.1.5	Explore and synthesize engineering requirements from larger social and professional concerns
			3.1.6	Determine design objectives, functional requirements and arrive at specifications
	3.3	Demonstrate an ability to select the optimal design scheme for further development	3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
4	4.1	Demonstrate an ability to conduct investigations of	4.1.1	Define a problem for purpose of investigation, its scope and importance

		technical issues consistent with their level of knowledge and understanding		
	4.3	Demonstrate an ability to critically analyze data to reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to collect and analyse data
6	6.1	Demonstrate the ability to describe engineering roles in a broader context, e.g. as pertains to the environment, health, safety, and public welfare	6.1.1	identify and describe various engineering roles; particularly pertaining to protection of the public and public interest
7	7.1	Demonstrate an understanding of the impact of engineering and industrial practice on social, environmental and economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
			7.1.2	Demonstrate an understanding of the relationship between the technical, socio-economic and environmental dimensions of sustainability
8	8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
12	12.2	Demonstrate an ability to Identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that require practitioners to seek education in order to stay updated
			12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep updated regarding new developments in the field

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.

Unit Learning Outcomes (ULO):

Sl.	Unit Learning Outcome (ULO)	CO's	BLL	PI addressed
	Unit -II			
1.	Students shall be able to define basic terms associated with irrigation systems	**CO 1**	**1**	**1.2.1**
2.	Students shall be able to list need for irrigation and ill effects of irrigation	**CO 1**	**1**	**2.1.1**
3.	Students shall be able to illustrate the various type of irrigation methods	**CO 1**	**2**	**2.1.1**
4.	Students shall be able to identify pros and cons of different micro irrigation systems	**CO 1**	**2**	**4.1.1**
5.	Students shall be able to identify energy saving potential in irrigation systems	**CO 1**	**3**	**1.3.1**
6.	Students shall be able to suggest methodology to optimum sizing of irrigation pumps	**CO 1**	**4**	**2.1.1**
7.	Students shall be able to list and describe govt. Initiatives in irrigation systems	**CO 1**	**1**	**6.1.1**
8.	Students shall be able to illustrate the working principle of different connection topologies of SPV pumps	**CO 1**	**2**	**4.1.1**
9.	Students shall be able to list and describe pros and cons of SPV pumps.	**CO 1**	**2**	**4.1.1**
	Unit –II			
10.	Students shall be able to describe the concept of evapotranspiration	**CO 2**	**2**	**1.4.1**
11.	Students shall be able to illustrate different growth stages	**CO 2**	**3**	**1.4.1**

	of crops for water requirement assessment			
12.	Students shall be able to carry out assessment of evapotranspiration by different methods	**CO 2**	**4**	**4.3.1**
13.	Students shall be able to list the crop factors of various crops and assess water need for irrigation for respective crops	**CO 2**	**3**	**2.1.1**
14.	Students shall be able to assess hydraulic head offered at the specified conditions	**CO 2**	**3**	**4.1.1**
15.	Students shall be able to select the hp rating of pumps for given conditions	**CO 2**	**4**	**1.4.1** **3.1.4**
16.	Students shall be able to evaluate the assessment of energy conservation and saving potential of proposed irrigation pump schemes	**CO 2**	**4**	**3.1.5** **3.1.6**
	Unit –III			
17.	Students shall be able to describe the basic working principle of solar photovoltaic systems	**CO 3**	**2**	**4.1.1**
18.	Students shall be able to carry out basic calculations of solar photovoltaic panels and arrays	**CO 3**	**3**	**12.2.1** **12.2.2**
19.	Students shall be able to identify issues in sizing the SPV based pumps for selected field conditions	**CO 3**	**2**	**2.1.1**
20.	Students shall be able to list govt. Schemes for SPV irrigation systems	**CO 3**	**2**	**6.1.1**
21.	Students shall be able to selection of SPV array capacity & connection configuration for the optimal pump selected	**CO 3**	**3**	**2.2.2** **3.3.2**
22.	Students shall be able to conduct economic analysis to evaluate the payback period of the solar PV systems	**CO 3**	**4**	**2.2.2** **7.1.1** **7.1.2**
	Unit –IV			
23.	Students shall be able to identify and list components of drip irrigation systems	**CO 4**	**1**	**2.1.1**
24.	Students shall be able to draw and understand layout of drip irrigation	**CO 4**	**2**	**6.1.1**
25.	Students shall be able to carry out selection of lateral pipelines in drip irrigation systems	**CO 4**	**3**	**4.1.1**
26.	Students shall be able to size pumping unit employed in drip irrigation systems	**CO 4**	**4**	**4.1.1**
27.	Students shall be able to carry out cost and energy analysis for drip irrigation systems	**CO 4**	**4**	**2.2.4**
28.	Students shall be able to identify and list components of micro sprinkler irrigation systems	**CO 4**	**1**	**2.1.1**
29.	Students shall be able to draw and understand layout of micro sprinkler irrigation systems	**CO 4**	**2**	**6.1.1**
30.	Students shall be able to size pumping unit employed in micro sprinkler irrigation systems	**CO 4**	**3**	**4.1.1**
31.	Students shall be able to carry out cost and energy analysis for micro sprinkler irrigation systems	**CO 4**	**4**	**2.2.4**

Course Content:

UNIT – I	(10 Hours)
Introduction to irrigation systems: Need for Irrigation and ill effects of irrigation, Type of irrigation methods, Micro irrigation systems – pros and cons, Energy saving potential in irrigation systems, Optimum sizing of pumps, Govt. initiatives in irrigation systems, Solar photovoltaic powered irrigation pumps, Different connection topologies of SPV pumps, pros and cons of SPV pumps.	
UNIT – II	**(10 Hours)**
Sizing of grid connected irrigation pumps: Crop water assessment: Concept of evapotranspiration, Growth stages of crops, Different methods for assessment of evapotranspiration, Crop factors. Assessment of hydraulic head and HP rating of pumps, Assessment of energy conservation and saving potential.	
UNIT – III	**(10 Hours)**
SPV based irrigation pumps: Solar photovoltaic basics, Issues in sizing the SPV based pumps, Govt. schemes for SPV irrigation systems, Selection of SPV array capacity & connection configuration, Economic analysis.	
UNIT – IV	**(10 Hours)**
Micro Irrigation Systems: Drip Irrigation Systems: Components used, Layout of drip irrigation, Selection of lateral pipelines, Sizing of pumping unit, Cost and Energy Analysis. Micro Sprinkler Irrigation Systems: Required resources and conditions, Layout, Selection of Sprinkler and spacing, Capacity of Sprinkler pumping unit, Cost and Energy Analysis.	

Course Content Delivery:

Sl.	Hours Required	Topic to be covered	Mode of Delivery
1.	01	Introduction to irrigation systems	Ppt, Discussions
2.	01	Need for Irrigation and ill effects of irrigation	Ppt, Discussions
3.	01	Type of irrigation methods	Ppt, Discussions
4.	01	Micro irrigation systems – pros and cons	Ppt, Discussions
5.	01	Energy saving potential in irrigation systems	Ppt, Discussions
6.	01	Optimum sizing of pumps	Ppt, Discussions
7.	01	Govt. initiatives in irrigation systems	Ppt, Discussions
8.	01	Solar photovoltaic powered irrigation pumps	Ppt, Discussions
9.	01	Different connection topologies of SPV pumps	Ppt, Discussions
10.	01	pros and cons of SPV pumps	Ppt, Discussions
11.	01	Sizing of grid connected irrigation pumps- Introduction	Ppt, Discussions
12.	01	Crop water assessment methods	Ppt, Discussions
13.	01	Concept of evapotranspiration	Ppt, Discussions
14.	01	Growth stages of crops	Ppt, Discussions
15.	01	Different methods for assessment of evapotranspiration	Ppt, Discussions
16.	01	Different methods for assessment of evapotranspiration	Ppt, Discussions

17.	01	Crop factors	Ppt, Discussions
18.	01	Assessment of hydraulic head in pipe network	Ppt, Discussions
19.	01	Assessment of HP rating of pumps	Ppt, Discussions
20.	01	Assessment of energy conservation and saving potential	Ppt, Discussions
21.	01	Solar photovoltaic basics – Cell, Module, Panel and Array	Ppt, Discussions
22.	01	Issues in sizing the SPV based pumps	Ppt, Discussions
23.	01	Issues in sizing the SPV based pumps – cont..	Ppt, Discussions
24.	01	Govt. schemes for SPV irrigation systems	Ppt, Discussions
25.	01	Selection of SPV array capacity	Ppt, Discussions
26.	01	connection configurations of SPV systems	Ppt, Discussions
27.	01	Selection & connection configuration – Case study	Ppt, Discussions
28.	01	Economic analysis – Payback period calculation	Ppt, Discussions
29.	01	Case study –I	Ppt, Discussions
30.	01	Case study –II	Ppt, Discussions
31.	01	Drip Irrigation Systems: Components used	Ppt, Discussions
32.	01	Layout of drip irrigation	Ppt, Discussions
33.	01	Selection of lateral pipelines	Ppt, Discussions
34.	01	Sizing of pumping unit	Ppt, Discussions
35.	01	Cost and Energy Analysis	Ppt, Discussions
36.	01	Micro Sprinkler Irrigation- Required resources, conditions	Ppt, Discussions
37.	01	Layout of Micro Sprinkler Irrigation Systems	Ppt, Discussions
38.	01	Selection of Sprinkler and spacing	Ppt, Discussions
39.	01	Capacity of Sprinkler pumping unit	Ppt, Discussions
40.	01	Cost and Energy Analysis	Ppt, Discussions

Review Questions (Sample Questions):

Sl.	Review Questions	CO	BLL	PI addressed
1.	List and explain the new Initiatives taken up by central government for supporting Agriculture sector.	**01**	**1**	**2.1.1**
2.	Define Farm Power. List and explain the various sources of energy employed in agriculture.	**01**	**2**	**2.1.1**
3.	Describe the importance of agriculture in overall development of Indian economy.	**01**	**2**	**4.1.1**
4.	List and explain the energy conservation opportunities in agriculture sector.	**01**	**2**	**2.1.1**
5.	What is irrigation? Explain the need for irrigation and its ill-effects on environment.	**01**	**2**	**2.1.1**
6.	List and describe the different types of irrigation methods employed in Indian agriculture. Explain the pros and cons of each method.	**01**	**2**	**2.1.1**
7.	List the different types of pumps employed in Irrigation and explain the pros and cons of each.	**01**	**2**	**2.1.1**
8.	With neat graphic representation, describe the working principle of centrifugal pumps.	**01**	**2**	**4.1.1**

9.	List advantages and disadvantages of centrifugal pumps.	**02**	**2**	**2.1.1**
10.	List advantages and disadvantages of reciprocating pumps.	**02**	**2**	**2.1.1**
11.	Write a note on history of development of irrigation in India.	**01**	**2**	**2.1.1**
12.	Write a note on electricity consumption of irrigation loads in India. Brief about issues associated with demand management in agriculture sector.	**02**	**2**	**4.1.1**
13.	Explain the analogy between the elements of electrical circuits and hydraulic systems.	**02**	**3**	**2.1.1**
14.	Explain the concept of evapotranspiration employed for assessment of crop water assessment. With equations, explain the different methods for assessment of evapotranspiration.	**03**	**3**	**2.1.1**
15.	Define Reference Crop Evapotranspiration.	**02**	**2**	**2.1.1**
16.	List and explain the different growth stages of agricultural crops. Further, explain the significance of growth stages in assessment of irrigation pump capacity.	**02**	**2**	**2.1.1**
17.	Explain the procedure for assessment of hydraulic head offered in agriculture lands with PVC pipes used in pipe networks.	**02**	**2**	**4.1.1**
18.	Explain the typical characteristic curves of centrifugal pumps for a given speed.	**02**	**2**	**2.1.1**
19.	Explain the detailed methodology for assessment of optimal HP rating for grid connected conventional irrigation systems.	**02**	**2**	**2.1.1**
20.	Explain the concept and significance of economic diameter of pipe networks.	**02**	**2**	**2.1.1**
21.	Explain the benefits of optimal sizing of irrigation pumps.	**02**	**2**	**2.1.1**
22.	Describe priming and cavitation in centrifugal pumps.	**02**	**2**	**2.1.1**
23.	What is water hammer effect? Explain, how it can be prevented?	**02**	**2**	**2.1.1**
24.	Explain the selection of PVC pipe diameter of pipe networks of irrigation systems.	**02**	**3**	**4.1.1**
25.	Write a note on assessment of cost savings and mitigation of CO_2 elimination to environment by energy conservation in agriculture sector.	**03**	**2**	**2.1.1**
26.	Specify the distinct advantages of sprinkler irrigation over other methods of irrigation water application.	**04**	**2**	**2.1.1**
27.	Write a note on troubleshooting in sprinkler irrigation systems.	**04**	**2**	**2.1.1**
28.	List and explain significance of each of the components of sprinkler irrigation system.	**04**	**2**	**2.1.1**
29.	List the advantages of drip irrigation systems in detail.	**04**	**2**	**2.1.1**
30.	List and explain in detail various types of sprinkler irrigation systems.	**04**	**2**	**2.1.1**
31.	Define uniformity coefficient in sprinkler irrigation. Explain its significance.	**04**	**2**	**2.1.1**
32.	Explain the impact of sprinkler systems on electric energy	**04**	**2**	**2.1.1**

	conservation.			
33.	Explain the steps involved in design of sprinkler irrigation systems.	**04**	**2**	**2.1.1**
34.	What are the limitations of large scale adaption of sprinkler irrigation systems?	**04**	**2**	**2.1.1**
35.	Write note on following: Spray Irrigation, Bubbler Irrigation, Micro-Sprinklers	**04**	**2**	**2.1.1**
36.	Explain the steps involved in drip irrigation systems.	**04**	**2**	**2.1.1**
37.	List and explain significance of each component of drip irrigation system.	**04**	**2**	**2.1.1**
38.	Explain the method to assess pump capacity in drip irrigation systems.	**04**	**2**	**2.1.1**
39.	Describe how electricity can be conserved through drip irrigation systems.	**04**	**2**	**2.1.1**

Reference Books:

1. A.M.Michael, "Irrigation Theory and Practice", Vikas Publishers, Second Enlarged Edition, 2011.
2. Basanagouda F. Ronad, S H Jangamshetti, "Optimum Sizing of SPV Irrigation Systems based on Field Conditions", LAP LAMBERT Academic Publishing, August 2018.
3. M.Kay, N.Hatcho, "Small-Scale Pumped Irrigation: Energy and Cost", Irrigation Water Management Training Manual, Food and Agriculture Organization of United States, Rome, 1992.

Evaluation Scheme:

Assessment	Marks	Weightage
Continuous Internal Evaluation, CIE-I	20	20
Continuous Internal Evaluation, CIE-II	20	20
Assignments/ Quizzes/Case Study/ Course Project/Term Paper/Field Work	10	10
Semester End Examination SEE	100	50
Total	**150**	**100**

Details of Assignment:

Assignment	Marks (10)	CO	PI	CA	PO
Assignment 1 (Write and Submit)	02	CO 1	1.2.1 2.1.1 4.1.1 1.3.1 2.1.1 6.1.1		PO1, PO2, PO4, PO6
Assignment 2 (Write and Submit)	02	CO 2	1.4.1 4.3.1 2.1.1 4.1.1 3.1.4 3.1.5 3.1.6		PO1, PO2, PO3, PO4
Assignment 3 (Case Study)	02	CO 3	1.2.1 4.1.1 12.2.1 12.2.2 2.1.1 6.1.1 2.2.2 3.3.2 7.1.1 7.1.2		PO1, PO2, PO3, PO4, PO6, PO7, PO12
Assignment 4 (Case Study)	02	CO 4	1.2.1 2.1.1 6.1.1 4.1.1 2.2.4 4.1.1		PO1, PO2, PO4, PO6
Assignment 5 QUIZ/ Course Project	02	CO1- CO4			PO1, PO2, PO3, PO4, PO6, PO7, PO12

Dr.BasanagoudaRonad