University of Sargodha
College of Engineering and Technology
Department of Electrical Engineering

Course File
Electrical Network Analysis (ENA) EE-218

Semester / Session: 3rd/2019-2023

Instructor: Engr. Muhammad Nadeem
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Office Hours: 08:00 hrs to 16:00 hrs

Course TA: N.A.

Course Description: To equip the students with the knowledge and techniques of analyzing electrical networks. The course introduces the analysis of AC circuits (comprising resistors, capacitors, and inductors) excited by sinusoidal sources. 2nd ODE (RLC Circuits). The concept of complex frequency, single-phase circuit analysis, Phasors, complex impedance, star-delta transformation, Power Analysis, Application of Laplace Transforms in circuits analysis, and understand the two-port network. The purpose is to make students familiar with the modern hierarchy of AC circuits analysis and explain to them the state-of-the-art electrical network analysis.

Catalog Data:

Course Code:	EE-218
Course Title:	Electrical Network Analysis (ENA) Theory
Credit Hours:	3
Course Designation:	Core
No of Sessions per week:	2 (Total 32 sessions)
Session Duration:	90 min

Catalog Description: Electrical Network Analysis (ENA) **, Credits (3)**
Current and voltage transients, RLC circuits with DC and AC excitation, resonant circuit: series and parallel resonance in AC circuit, Q-Factor, mutual inductance and transformers, introduction to phasors representation of alternating voltage and current, single-phase circuit analysis, star-delta transformation for DC and AC circuits, poly-phase generators, phase sequence, vector diagrams for balance and unbalanced three phase networks, power in three phase circuits and different methods of its measurements. Two-port networks and their interconnections. Application of Laplace transform in circuit analysis.

Prerequisite: Linear Circuit Analysis
Prerequisites by Topics: NIL

Co-requisite: NIL

Textbook:

C. Alexander and M. Sadiku, "**Fundamentals of Electric Circuits**", McGraw- Hill, 5th Edition, 2013

References:

1. J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008

2. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest edition).

3. R E Thomas, A. J. Rosa and G. J. Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009.

Program Learning Outcome: This course is designed in conjunction with the following PLOs.

PLO 1. Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO 2. Problem Analysis: An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO 3. PLO-03: Design/Development of Solutions: An ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

Course Learning Outcome (CLO):
Upon successful completion of this course, the student will be able to:

CLO No	Course Learning Outcome (CLO) Statements	CLO Domain	Mapped PLO	Assessment Tool
CLO-1	Able to ***Analyze*** RLC circuits and differentiate between Transient and Steady-State responses. ***Analyze*** time-domain phasors & frequency domain AC circuits (Current, Voltage & Impedance).	**C4 (Analyzing)**	**PLO 1**	**A1, Q1, Mid (MP-1), FP-1**
CLO-2	***Analyze*** the time domain and frequency domain response of a single-phase circuit (AC Theorems Analysis). **Analyze** polyphase systems, AC Power analysis and Magnetically coupled circuits (Mutual Inductance, Q factor)	**C4 (Analyzing)**	**PLO 2**	**A2, Q2, Mid (MP-1), FP-2**
CLO-3	**Compute** the circuits for constant/non constant forcing functions in time, frequency and s domain, **Appling** Laplace transform and two port networks	**C3 (Applying)**	**PLO 3**	**A3,Q3, FP-3**

NOTE: Domain: C = Cognitive,

Assessment Tool: A = Assignment, Q = Quiz, M = Midterm, F = Final (P1: Part1)

PLO weightage detail

PLO list	Weightage	Remarks
PLO 1	20 %	Engineering Knowledge
PLO 2	**50 %**	Problem Analysis
PLO 3	30 %	Design/Development of Solution
Total Weightage	**100 %**	

Course Professional Outcome/ Industrial Usage:
After successful completion of this course, the student should be able to: Use Kirchhoff's laws, circuit theorems and node voltage methodology to solve 1. AC circuits. 2. Solve 2nd order transient circuits. 3. Apply steady state sinusoidal analysis to circuits. 4. Demonstrate a understanding of phasors and phasors diagrams for AC circuit analysis. 5. Reflect a understanding of transformer operation, through analysis of transformer circuits. 6 Apply Laplace Transformation and two-port networks. The purpose is to make students familiar with modern hierarchy of AC circuit examination and explain them the state-of-the-art electrical network analysis.

Computer Usage: N/A.

Projects / Design Activities: Students will be asked to design project /solve complex engineering problem.

Evaluation Criteria:

1. Assignments	03 %
2. Quizzes	09 %
3. Project	08 %
4. Mid-Term Exam	30%
5. Final Exam	50% (MCQ + Voce Viva)

Course Outline and Sessions Breakdown:

I. Analyzing Second order Circuits (CLO 1)
(6 sessions)
Introduction to Capacitor & Inductor, understanding of Steady state & transit response of RC & RL, / Step response of an RL & RC Circuits. Current and voltage transients in RLC circuits with DC and AC excitation, finding initial & final value, The Source free series/ parallel RLC Circuits, General 2nd order circuit deriving equations (overdamped, underdamped, and critically damped).

II. AC Circuits (Sinusoids & Phasors) analysis CLO 1
(6 sessions)
Introduction to Sinusoids and Phasors, Phasors Relationships for Circuit Elements (Time Domain & Phasors Domain) Impedance & Admittance & their Combination, Kirchhoff's Laws in the frequency domain. **Star-delta** transformation in DC & AC, voltage-division relationship & current-division principle. Application of Single-Phase circuits as Phase Shifter & AC Bridges.

III. AC Circuits (AC Network Theorems) Analysis CLO 2
(8 sessions)
AC Circuit Analysis using Nodal Analysis, Super Node, Mesh, Analysis, and Super Mesh. Analysing circuit using Superposition Theorem and Source Transformation Theorem, Thevenin and Norton Theorem. AC Power Analysis, Instantaneous and Average Power. Maximum Power Transfer Theorem**,** Effective or RMS Value, Apparent Power, Power Triangle, Power Factor, and Power Factor Correction / Improvement.

IV. Poly-Phase Circuits Analysis CLO 2
(6 sessions)
Poly phase circuits, phase sequence, vector diagrams for balance three phase networks, balanced three-phase voltages, balanced wye-wye connection, balanced wye-delta connection. balanced delta-delta connection, balanced delta-wye connection, power in a balanced system. Unbalance three phase system. Introduction to Magnetically coupled circuits, Q-Factor, mutual inductance, Linear Transformer & Ideal Transformer.

V. Application of Laplace Transform & Two port Network CLO 3
(6 sessions)

Application of Laplace & inverse Laplace transform, circuit. element model, circuit analysis using Laplace & inverse Laplace transform. Transfer function and their application as network stability, initial and final value theorems. Understanding the concept of Two-Port networks, Impedance Parameter (Z- Parameters), Admittance Parameters, (Y-Parameters) , Hybrid Parameters, (h- Parameters), Inverse Hybrid Parameters, (g- Parameters) , Transmission Parameters (ABCD or T - Parameters) and two port network application as transistor circuits,

COURSE DISTRIBUTION ON WEEKLY BASIS

Weeks	Course Contents / Topic of the Lecture	**Quiz/ Assignment**
WEEK 01	**Analyzing First order Circuits** Introduction to Capacitor & Inductor, understanding of Steady state & transit response of RC & RL (1st Order Circuits) / Step response of an RL & RC Circuit	
WEEK 02	**Analyzing Second order Circuits:** Current and voltage transients, RLC circuits with DC and AC excitation, Finding initial & final value, The Source free series RLC Circuits,	
WEEK 03	The Source fee Parallel RLC Circuits, Step Response of Series & Parallel RLC circuits. General Second order circuits deriving equations (over damped., under damped. & critically damped cases).	
WEEK 04	**AC Circuits (Steady State) Analysis** Introduction to Sinusoids and Phasors, Phasors Relationships for Circuit Elements (Time Domain & Phasors Domain) Impedance & Admittance & their Combination, Kirchhoff's Laws in the Frequency Domain.	
WEEK 05	**Star-delta** transformation in DC & AC, voltage-division relationship & current-division principle. Application of Single-Phase circuits as Phase Shifter & AC Bridges	**Assignment 1**
WEEK 06	**AC Network Theorems**, AC Circuit Analysis using Nodal Analysis , Super Node , Mesh Analysis ,and Super Mesh	
WEEK 07	Analyzing circuit using Superposition Theorem and Source Transformation Theorem	**Quiz 1**
WEEK 08	Thevenin and Norton Theorem, Summary and Revision.	
WEEK 09	**Mid Term Exam**	
WEEK 10	AC Power Analysis, Instantaneous and Average Power **Maximum Power Transfer Theorem,** Effective or RMS Value, Apparent Power, Power Triangle, Power Factor, and Power Factor Correction	
WEEK 11	**Poly-phase circuits**, phase sequence, vector diagrams for balance and unbalanced three phase networks, balanced three-phase voltages, balanced wye-wye connection, balanced wye-delta connection,	

WEEK 12	balanced delta-delta connection, balanced delta-wye connection, power in a balanced system.	**Assignment 2**
WEEK 13	Introduction to Magnetically coupled circuits, Q-Factor, mutual inductance, Linear Transformer & Ideal Transformer.	**Quiz 2**
WEEK 14	Understanding the Laplace & inverse Laplace transformation, properties of Laplace transformation	
WEEK 15	Application of Laplace transform, circuit element model, circuit analysis.	
WEEK 16	Transfer function and their application as network stability, initial and final value theorems	**Assignment 3**
WEEK 17	Understanding the concept of Two-Port networks, Impedance Parameter (Z- Parameters) , Admittance Parameters, (Y- Parameters) , Hybrid Parameters, (h- Parameters), Inverse Hybrid Parameters, (g- Parameters) , Transmission Parameters (ABCD or T - Parameters) and two port network application as transistor circuits,	**Quiz 3**
WEEK 18	Final Term Examination	

Policies

(a) No makeup tests or quizzes, except in case of emergency, e.g. illness and accident. For make up tests, medical certificate is required, and the instructor must be notified in advance of the test.
(b) No late assignment will be accepted.