Department of Electronics and Communication Engineering

Details of Lesson Plan

S.No.	Particulars	Details
1.	Course Name	Digital Signal Processing
2.	Course Code	ECE-502
3.	Academic Year	2024-25
4.	Semester	5th
5.	Number of Lesson plans	50
6.	Faculty Assigned	Prof (Dr) Ashok Kumar Ms. Gurpreet Kour

Faculty Signature

Lesson Plan No. 1	Course Name: Digital Signal Processing Topic: Introduction to Digital Signal Processing	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of analog and digital signals b. differentiate between analog and digital signal c. illustrate different applications of DSP d. appreciate advantages of Digital signal processing
Teaching Aids (if any)	a. Power point presentation b. Video on Introduction to DSP and its application
Teaching Development	1. **Introduction** (5 minutes) Ask questions - Welcome students to the new class. - Students will be given orientation of the syllabus/subject. - What do you mean by communication? - What is a signal? - What do you mean by digital signal? - What do you mean by analog signal? 2. **Development** (30 minutes) a. Time Signals - Introduction to discrete and continuous time signals - Show animated video explaining time signals - https://www.youtube.com/watch?v=33kbebX5fkk b. Signal processing - Definition - Block Diagram c. Advantages of DSP over Analog Signal Processing - Flexibility - Accuracy - Easy - Mathematical Processing - Cost - Repeatability - Adaptability - Universal Compatibility - Size and Reliability d. Application of DSP - Speech Processing - Image Processing

	- Telecommunication - Instrumentation Engineering - Control Applications - Biomedical Engineering - Military Application - Consumer Application -Industrial Engineering - Automotive -Commercial/ Entertainment Application 3. **Exercise (5 minutes)** – Activity: Summarization..
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading https://www.monolithicpower.com/en/analog-vs-digital-signal Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 2	**Course Name: Digital Signal Processing** **Topic: Classification of Signals-I**	**Course No.: ECE-502**

Objectives		At the end of the lesson the student shall be able to: a. articulate the mathematical concept of different types of signals b. illustrate the behavior of the signals graphically
Teaching Aids (if any)		a. Power point presentation b. Examples of AI applications
Teaching Development		**1. Introduction** (5 minutes) Ask questions - What is a signal? - What do you mean by analog and digital values? - Examples of analog and digital signals? **2. Development** (30 minutes)

		a. Representation of a signal - Representation of a signal in mathematical form - Representation of a signal in tabular form - Representation of a signal in graphical form b. Analog and Digital Signal - Definition - Representation of a signal in graphical form - Examples of Analog and Digital signals - Numerical on Analog and Digital signals c. Continuous and Discrete - Definition - Representation of a signal in graphical form - Examples of Continuous and Discrete - Numerical on Continuous and Discrete d. Periodic and Aperiodic Signals - Definition - Representation of a signal in graphical form - Examples of Periodic and Aperiodic signals - Numerical on Periodic and Aperiodic signals 3. **Exercise (5 minutes)** – Activity: Summarizing.
Closure		a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis (pg:6-11) 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation		1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Numerical practice questions. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 3	**Course Name: Digital Signal Processing** **Topic: Classification of signals-II**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the mathematical concept of different types of signals b. illustrate the behaviour of the signals graphically
Teaching Aids (if any)	a. Power point presentation
Teaching Development	1. **Introduction** (5 minutes) Ask Questions - What is a signal? - What do you mean by classification of signals? - Revision questions on analog and digital signals, continuous and discrete signals, periodic and aperiodic signals? 2. **Development** (30 minutes) a. Even and Odd Signal - Definition - Representation of a signal in graphical form - Examples of Even and Odd Signal - Numerical on Even and Odd Signal b. Deterministic and Random/Stochastic Signals - Definition - Representation of a signal in graphical form - Examples of Deterministic and Random signal - Numerical on Deterministic and Random signal c. Energy and Power Signals - Definition - Representation of a signal in graphical form - Examples of Energy and Power signals - Numerical on Energy and Power signals d. Real and complex Signals - Definition - Representation of a signal in graphical form - Examples of Real and Complex signals - Numerical on Real and Complex signals **3. Exercise (5 minutes)** – Practice questions using different types of signals
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis (pg:12-22) 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning

Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Allow students to identify and describe different signals Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 4	**Course Name: Digital Signal Processing** **Topic: Standard Signals**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the mathematical concept of commonly used signals b. Illustrate the behaviour of the standard signals.
Teaching Aids (if any)	a. Use of Google form tool for online quiz
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What is a difference between ac and dc signals? - What do you mean by a sinusoidal signal? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. DC signal - Representation of a signal in graphical form - Mathematical representation of a signal b. Sinusoidal signal - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal c. Unit Step signal - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal d. Signum function - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal e. Rectangular Pulse - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal

	f. Delta or unit impulse function - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal g. Unit Ramp Signals - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal h. Real and complex Signals - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal i. Real and complex Signals - Representation of a signal in graphical form: Continuous time - Representation of a signal in graphical form: Discrete time - Mathematical representation of a signal **3. Exercise (5 minutes) –** Practice questions using standard signals
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis (pg:47-52) 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Encourage students to identify different types of signals Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 5	**Course Name: Digital Signal Processing** **Topic: Classification of Systems**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the mathematical concept of digital systems. b. Illustrate the behavior and properties of the system.

Teaching Aids (if any)	a. PowerPoint presentation b. Examples of discrete systems
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What do mean by a system? - What do you mean by processing? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. Linear and Nonlinear system - Definition - Representation of a linear and nonlinear systems - Mathematical representation of a signal - Examples and Practice Questions b. Time Invariant and Time variant systems - Definition - Representation of a Time Invariant and Time variant systems - Mathematical representation of a signal - Examples and Practice Questions c. Static and Dynamic Systems - Definition - Representation of a Static and Dynamic systems - Mathematical representation of a signal - Examples and Practice Questions d. Invertible and Non-invertible systems - Definition - Representation of a Invertible and Non-Invertible systems - Mathematical representation of a signal - Examples and Practice Questions **3. Exercise (5 minutes)** – Activity: Visible Quiz
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis (pg: Pg:14-21, 43-47, 62-70) 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Encourage students to answer and discuss

	Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 6	**Course Name: Digital Signal Processing** **Topic: Properties of System**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Articulate the mathematical concept of digital systems. b. Illustrate the behavior and properties of the system.
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What do mean by a system? - What do you mean by processing? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. Causal and Non-causal systems - Definition - Representation of a Causal and non-causal systems - Mathematical representation of a signal - Examples and Practice Questions b. Stable and Unstable systems - Definition - Representation of a Stable and Unstable systems - Mathematical representation of a signal - Examples and Practice Questions c. Recursive and Non-Recursive Systems - Definition - Representation of a Recursive and Non-Recursive systems - Mathematical representation of a signal - Examples and Practice Questions **3. Exercise (5 minutes) –** Activity: Summarizing.
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis (pg: Pg:14-21, 43-47, 62-70) 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html

	Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Allow students to describe different systems. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 7	**Course Name: Digital Signal Processing** **Topic: Linear Time Invariant Systems**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of LTI systems b. Illustrate the behavior and properties of the LTI system. c. Appreciate the response of the system.
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What do mean by a system? - What are Linear systems? - What is Time variant systems? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. Properties of LTI systems - Definition - Homogenate principle - Superposition principle b. Response of a systems - Definition - Representation of a Impulse response of a systems - Mathematical representation - Examples and Practice Questions c. Convolution Sum - Definition - Representation of a Linear convolution - Derivation/Proof of linear convolution 3. **Exercise** (5 minutes) – Activity: One minute paper

Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis (pg: 75-85 Salivahanan Pg:238-245) 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Google form Quiz on Properties of Signal and systems. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 8	**Course Name: Digital Signal Processing** **Topic: Linear Convolution-I**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of convolution b. Illustrate the behavior and properties of linear convolution. c. Appreciate the response of the system.
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What do mean by a system? - What are Linear systems? - What are Time variant systems? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. Linear convolution - Derivation of linear convolution - Examples of linear convolution - Circular convolution(Introduction) b. Graphical Method (Linear Convolution) - Mathematical representation - Examples and Practice Questions c. Mathematical equation Method (Linear Convolution) - Mathematical representation - Examples and Practice Questions

	3. **Exercise (5 minutes) –** Activity: Practice questions
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis Pg:75-85 Salivahanan Pg:238-256 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 9	**Course Name: Digital Signal Processing** **Topic: Linear Convolution -II**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of convolution b. Illustrate the behavior and properties of linear convolution . c. appreciate the response of the system.
Teaching Aids (if any)	a. PowerPoint presentation b. Examples of linear convolution
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What do mean by a system? - What are Linear systems? - What are Time variant systems? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. Mathematical equation Method (Linear Convolution) - Mathematical representation - Examples and Practice Questions b. Tabulation Method (Linear Convolution) - Mathematical representation - Examples and Practice Questions

	c. Multiplication Method (Linear Convolution) - Mathematical representation - Examples and Practice Questions 3. **Exercise** (5 minutes) – Use Google form to collect responses and discuss the answers.
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis 85-90,208-211 A.Anand: Pg:65-73 Salivahanan: Pg:245-256 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 10	**Course Name: Digital Signal Processing** **Topic: Difference Equation**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of difference equation for LTI systems b. Illustrate the behavior systems described by difference equation. c. appreciate the response discrete LTI systems.
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do mean by a system? - What are Linear systems? - What are Time variant systems? - Revision questions on classification of signals? 2. **Development** (30 minutes) a. LTI discrete system via difference equation - Mathematical representation

	- Implicit specifications - Auxiliary conditions - Examples and Practice Questions b. Auxiliary condition of LTI system - Condition of initial rest. - Non-recursive equation - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarization.
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis Pg: 200-20 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 11	**Course Name: Digital Signal Processing** **Topic: Introduction to z-transform**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of time and frequency domain b. Illustrate the behavior of z-transform.
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask Questions - What do you understand by time domain? - What is frequency domain? - Revision questions on LTI systems? 2. **Development** (30 minutes) a. Introduction to Z-Transform - Mathematical representation(bidirectional) - Mathematical representation(unidirectional) - Mathematical representation (complex numbers) - Advantages of Z-transform b. Region of Convergence

	- Mathematical representation - Examples and Practice Questions c. Representation of Unit Impulse function - Z-transform of Unit Impulse function - Mathematical representation - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis Pg:151-172 Salivahanan Pg:193-204 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 12	**Course Name: Digital Signal Processing** **Topic: Impulse and step function (z-transform)**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of time and frequency domain b. Illustrate the behavior of z-transform.
Teaching Aids (if any)	a. Examples of z-transform b. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you understand by time domain? - What is frequency domain? - Revision questions on LTI systems? 2. **Development** (30 minutes) a. Z-transform of Delay Unit Impulse function - Representation of Delay Unit Impulse function - Mathematical representation

	- Examples and Practice Questions b. Z-transform of Advance Unit Impulse function - Representation of Advance Unit Impulse function - Mathematical representation - Examples and Practice Questions c. Z-transform of Unit step function - Representation of Unit step function - Mathematical representation - Examples and Practice Questions d. Z-transform as an operator - Representation - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.G.Proakis Pg:151-172 Salivahanan Pg:193-204 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 13	**Course Name: Digital Signal Processing** **Topic: Ramp and exponential function (z-transform)**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of representation of common signals by z-transform b. Illustrate the behavior of z-transform.
Teaching Aids (if any)	a. PowerPoint presentation b. Examples of functions
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you understand by time domain? - What is frequency domain? - Revision questions on LTI systems?

	2. **Development** (30 minutes) a. Z-transform of Unit Step function - Representation of Unit Step function - Mathematical representation - Region of Convergence - Examples and Practice Questions b. Z-transform of Unit Ramp function - Representation of Unit Ramp function - Mathematical representation - Region of Convergence - Examples and Practice Questions c. Z-transform of Exponential sequence - Representation of exponential sequence - Mathematical representation - Region of Convergence - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by Salivahanan Pg:205-213 A.Anand Pg:179-200 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 14	**Course Name: Digital Signal Processing** **Topic: Region of convergence**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of representation of common signals by z-transform b. Illustrate the properties of region of convergence.
Teaching Aids (if any)	a. PowerPoint presentation b. Animated video
Teaching Development	1. **Introduction** (5 minutes) Ask question

	- Describe unit step function. - What is RoC? - Why RoC is required? - Revision questions on LTI systems? 2. **Development** (30 minutes) a. Properties of RoC - z-plane centered at the origin - infinite duration causal sequence - finite duration causal sequence - infinite duration anti-causal sequence - finite duration anti-causal sequence - finite duration two-sided sequence - infinite duration two-sided sequence. - Examples and Practice Questions b. Common Z-transform pairs - Representation of sequences x(n) - z-transform of the sequence X(z) - Region of Convergence - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by Salivahanan Pg:205-213 A.Anand Pg:179-200 2. http://www.nptelvideos.in/2012/12/digital-signal-processing.html Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 15	**Course Name: Digital Signal Processing** **Topic: Properties of z- transform-I**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of representation of common signals by z-transform b. Illustrate the properties of Z-transform
Teaching Aids (if any)	a. PowerPoint presentation

	b. Examples
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is linearity? - What does time shifting mean? - What is time reversal? 2. **Development** (30 minutes) a. Convolution Property - Mathematical representation - Proof of the expression - Examples and Practice Questions b. Time Expansion Property - Mathematical representation - Proof of the expression - Examples and Practice Questions c. Correlation Property - Mathematical representation - Proof of the expression - Examples and Practice Questions d. Multiplication by n or differentiation in z-domain Property - Mathematical representation - Proof of the expression - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Quiz
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.Proakis Pg:151-172 Salivahanan Pg:193-204 2. https://youtu.be/qPpNYGAQf20 https://youtu.be/gkC7cXa8ewk https://youtu.be/BAfdk3mwByM Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 16	Course Name: Digital Signal Processing Topic: Properties of z- transform-II	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of representation of common signals by z-transform b. Illustrate the properties of Z-transform
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is convolution property? - What does time expansion mean? - What is convex convolution? 2. **Development** (30 minutes) a. Parseval's theorem or Property - Mathematical representation - Proof of the expression - Examples and Practice Questions b. Initial value theorem - Mathematical representation - Proof of the expression - Examples and Practice Questions c. Final value theorem - Mathematical representation - Proof of the expression - Examples and Practice Questions d. Multiplication or convex convolution Property - Mathematical representation - Proof of the expression - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.Proakis Pg:151-172 Salivahanan Pg:193-204 2. https://youtu.be/qPpNYGAQf20 https://youtu.be/gkC7cXa8ewk https://youtu.be/BAfdk3mwByM

	Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 17	**Course Name: Digital Signal Processing** **Topic: Inverse z- transform -I**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of representation of common signals by Inverse z-transform b. Illustrate the performance of methods to calculate inverse Z-transform
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is time domain? - What do you mean by frequency domain? - What is z- transform? 2. **Development** (30 minutes) a. Introduction to inverse z-transform - Definition - Mathematical representation - Examples and Practice Questions b. Long division method - Mathematical representation - Proof of the expression - Examples and Practice Questions c. Partial Fraction Expansion method - Mathematical representation - Proof of the expression - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these.

	b. Suggested Reading 1. Digital signal Processing by J.Proakis Pg:184-187 Salivahanan Pg:213-221 2. https://youtu.be/qPpNYGAQf20 https://youtu.be/gkC7cXa8ewk https://youtu.be/BAfdk3mwByM Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 18	**Course Name: Digital Signal Processing** **Topic: Inverse z- transform -II**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of representation of common signals by Inverse z-transform b. Illustrate the performance of methods to calculate inverse Z-transform
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is time domain? - What do you mean by frequency domain? - What is z- transform? 2. **Development** (30 minutes) a. Introduction to inverse z-transform - Definition - Mathematical representation - Examples and Practice Questions b. Residue Method - Mathematical representation - Proof of the expression - Examples and Practice Questions c. Convolution Method - Mathematical representation - Proof of the expression - Examples and Practice Questions

	3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading 1. Digital signal Processing by J.Proakis Pg:184-187 Salivahanan Pg:213-221 2. https://youtu.be/qPpNYGAQf20 https://youtu.be/gkC7cXa8ewk https://youtu.be/BAfdk3mwByM Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 19	**Course Name: Digital Signal Processing** **Topic: Relationship between z-transform and Fourier transform**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Outline the fundamental differences and similarities between Z-Transform and Fourier Transform. b. Apply Z-Transform and Fourier Transform in signal analysis. c. Recognize the use cases for each transform in digital signal processing.
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What do you know about Fourier Transform? - Have you heard of Z-Transform? Brief overview of how Z-Transform and Fourier Transform are essential in digital signal processing. 2. **Development** (30 minutes) a. Review of Fourier Transform - Explain the Fourier Transform in the context of continuous and discrete signals. - Discuss the importance of frequency domain analysis. b. Introduction to Z-Transform: - Define Z-Transform and its role in discrete signal analysis. - Explain the relationship between the Z-Transform and the Discrete-Time Fourier Transform (DTFT).

	c. Comparison: - Illustrate the relationship between Z-Transform and Fourier Transform. - Discuss the concept of the region of convergence (ROC) in Z-Transform and its implications for stability and causality. - Provide examples of how both transforms can be used in practical signal analysis scenarios 3. **Exercise** (5 minutes) – Activity: Solve a problem to find the Z-Transform and Fourier Transform of a given discrete signal.
Closure	a. Summarize the key points of the relationship between Z-Transform and Fourier Transform. b. Suggested Reading 1. Digital signal Processing by J.Proakis Pg:188-190 Salivahanan Pg:222-225 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How do the Z-Transform and Fourier Transform relate? When would you use one over the other? 2. Encourage students to answer and discuss Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 20	**Course Name: Digital Signal Processing** **Topic: All Pass Filters**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Model the structure and purpose of all-pass filters. b. Analyze the phase response of all-pass filters. c. Apply all-pass filters in phase compensation applications.
Teaching Aids (if any)	a. PowerPoint presentation b. MATLAB for filter design and simulation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is a filter, and what types of filters have you studied? - Have you encountered all-pass filters before? Brief introduction to the concept of all-pass filters. 2. **Development** (30 minutes) a. Introduction to All pass filters - Define all-pass filters and explain their unique property of having a constant magnitude response while varying phase. - Discuss the mathematical formulation of all-pass filters.

	b. Phase Response - Explain the importance of phase response in signal processing. Illustrate the phase response of all-pass filters with examples. - Mathematical representation c. Applications - Discuss applications such as phase equalization and delay compensation. 3. **Exercise** (5 minutes) – Activity: Design a simple all-pass filter using MATLAB and analyze its phase response.
Closure	a. Summarize the significance of all-pass filters in digital signal processing. b. Suggested reading: "Digital Signal Processing with MATLAB" by Vinay Ingle and John Proakis. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: What is the primary function of an all-pass filter? How can it be applied in practical scenarios? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 21	**Course Name: Digital Signal Processing** **Topic: Minimum-Phase, Maximum-Phase, and Mixed-Phase Systems**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Differentiate between minimum-phase, maximum-phase, and mixed-phase systems. b. Analyze the significance of phase in system behavior. c. Apply knowledge of phase characteristics in the design and analysis of digital filters.
Teaching Aids (if any)	a. PowerPoint presentation b. MATLAB for filter design and phase analysis
Teaching Development	1. **Introduction** (5 minutes). Ask question - What do you know about phase in signal processing? - Have you studied the concept of minimum-phase systems? Brief overview of phase characteristics in systems. 2. **Development** (30 minutes) a. Minimum-Phase Systems

	- Define minimum-phase systems and explain their properties. - Discuss the significance of minimum-phase in achieving a causal and stable system. b. Maximum-Phase Systems - Define maximum-phase systems and contrast them with minimum-phase systems. - Discuss the impact of maximum-phase on system stability and behavior. c. Mixed-Phase Systems - Introduce mixed-phase systems and explain their composition from minimum-phase and maximum-phase components. - Provide examples where mixed-phase systems are used in practice. 3. Exercise (5 minutes) – Activity: Analyze a given system's phase response and categorize it as minimum-phase, maximum-phase, or mixed-phase.
Closure	a. Summarize the key differences between minimum-phase, maximum-phase, and mixed-phase systems. b. Suggested reading: "Digital Signal Processing: A Practical Guide for Engineers and Scientists" by Steven Smith. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How do phase characteristics influence system design? What are the implications of using a minimum-phase versus a maximum-phase system? 2. Encourage student discussion and participation. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 22	**Course Name: Digital Signal Processing** **Topic: Applications of Z-Transform**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Identify various applications of Z-Transform in digital signal processing. b. Use Z-Transform in the analysis and design of digital filters. c. Solve real-world problems using Z-Transform techniques
Teaching Aids (if any)	a. PowerPoint presentation b. MATLAB for solving Z-Transform problems
Teaching Development	1. **Introduction** (5 minutes). Ask question - How have you used Z-Transform in previous studies?

	- Why is the Z-Transform important in digital signal processing? Brief overview of the role of Z-Transform in digital signal processing. 2. **Development** (30 minutes) a. Applications in Filter Design - Explain how Z-Transform is used in the design and analysis of digital filters. - Provide examples of low-pass, high-pass, and band-pass filters designed using Z-Transform. b. System Stability Analysis - Discuss how Z-Transform helps in determining the stability and causality of a system. - Illustrate this with examples of system stability analysis. c. Signal Analysis - Explain how Z-Transform is used in the analysis of discrete-time signals and systems. - Discuss applications in convolution, difference equations, and system response. 3. Exercise (5 minutes) – Activity: Solve a problem involving the application of Z-Transform in filter design.
Closure	a. Summarize the various applications of Z-Transform in digital signal processing. b. Suggested reading: "Discrete-Time Signal Processing" by Oppenheim and Schafer. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: What are some practical applications of Z-Transform? How does it assist in solving digital signal processing problems? 2. Engage students in discussion and reflection Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 23	**Course Name: Digital Signal Processing** **Topic: Introduction to FIR structures**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of basic building blocks and signal flow graphs of discrete time signals b. Illustrate the performance of basic structure of FIR and IIR systems

Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is a FIR system? - What do you mean by IIR systems? - What is an adder? 2. **Development** (30 minutes) a. Introduction to impulse response systems - Types - Basic building blocks- adder, Multiplier, unit delay - Comparison between FIR and IIR systems - Types of structures for FIR and IIR systems b. Direct form I of FIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions c. Direct form II of FIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions d. Cascade form of FIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading Digital signal Processing by J.Proakis- Pg:116-118 A.Anand Pg:324-340 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 24	Course Name: Digital Signal Processing Topic: Introduction to IIR structures-I	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of basic building blocks and signal flow graphs of discrete time signals b. Illustrate the performance of basic structure of IIR systems
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is a FIR system? - What do you mean by IIR systems? - What is an adder? 2. **Development** (30 minutes) a. Introduction to IIR impulse response systems - Types - Basic building blocks- adder, Multiplier, unit delay - Comparison between FIR and IIR systems - Types of structures IIR systems b. Direct form I of IIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions c. Direct form II of IIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading Digital signal Processing by J.Proakis- Pg:111-116 A.Anand Pg:227-310 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to

	answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 25	Course Name: Digital Signal Processing Topic: Introduction to IIR structures-II	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of basic building blocks and signal flow graphs of discrete time signals b. Illustrate the performance of basic structure of FIR and IIR systems
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is a FIR system? - What do you mean by IIR systems? - What is an adder? 2. **Development** (30 minutes) a. Introduction to IIR impulse response systems - Comparison between Direct form I and Direct form II structures - Types of structures IIR systems b. Cascade form of IIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions c. Transport form II of IIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: One minute paper
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading

	Digital signal Processing by J.Proakis- Pg:111-116 A.Anand Pg:227-310 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 26	**Course Name: Digital Signal Processing** **Topic: Parallel and Cascade structure**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of basic building blocks and signal flow graphs of discrete time signals b. Illustrate the performance of basic structure of IIR systems
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is a FIR system? - What do you mean by IIR systems? - What is an adder? 2. **Development** (30 minutes) a. Introduction to IIR impulse response systems - Comparison between FIR and IIR systems - Types of structures IIR systems b. Parallel form of IIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions c. Lattice structure of IIR Structure - Block diagram/ structure - Proof of the expression - Examples and Practice Questions d. Ladder structure of IIR Structure - Block diagram/ structure - Proof of the expression

	- Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading Digital signal Processing by J.Proakis- Pg:111-116 A.Anand Pg:227-310 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 27	**Course Name: Digital Signal Processing** **Topic: Time and Frequency domain**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Fourier series and Fourier transform b. Illustrate the performance of DTFT, DFT and FFT
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask question - What is time domain? - What do you mean by frequency domain? - What are discrete signals? 2. **Development** (30 minutes) a. Introduction - Fourier transform - Discrete Time Fourier Transform (DTFT) - Discrete Fourier Transform (DFT) - Fast Fourier Transform b. Fourier Transform (FT) - Definition - Proof of the expression

	- Examples and Practice Questions c. Discrete Fourier Transform (DFT) - Block diagram/ structure - Proof of the expression - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Fourier Series and transform https://www.khanacademy.org/science/electrical-engineering/ee-signals ▪ Digital signal Processing by J.Proakis- Pg: 394-406,409-425 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 28	Course Name: Digital Signal Processing Topic: DTFT and DFT	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Fourier series and Fourier transform b. Illustrate the performance of DTFT, DFT and FFT
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes). Ask questions - What are discrete signals? - Difference between DTFT and DFT 2. **Development** (30 minutes) a. Discrete Time Fourier Transform (DTFT) - Derivation (DTFT)

	- Examples and Practice Questions b. Properties of Discrete Time Fourier Transform (DTFT) - Linearity property - Proof of the property - Examples and Practice Questions c. Properties of Discrete Time Fourier Transform (DTFT) - Time shifting property - Proof of the property - Examples and Practice Questions d. Properties of Discrete Time Fourier Transform (DTFT) - Time reversal property - Proof of the property - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Fourier Series and transform https://www.khanacademy.org/science/electrical-engineering/ee-signals ▪ Digital signal Processing by Salivahanan Pg:279-319 A.Anand Pg:358-398 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, why, Who?). 2. Allow students to answer and discuss on Introduction to Properties of DTFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 29	Course Name: Digital Signal Processing Topic: Properties of DTFT	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Fourier series and Fourier transform b. Illustrate the performance of DTFT, DFT and FFT
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask question - What are discrete signals? - Difference between DTFT and DFT 2. **Development** (30 minutes) a. Properties of Discrete Time Fourier Transform (DTFT) - Convolution property - Proof of the property - Examples and Practice Questions b. Properties of Discrete Time Fourier Transform (DTFT) - Frequency shifting property - Proof of the property - Examples and Practice Questions c. Properties of Discrete Time Fourier Transform (DTFT) - Multiplication property - Proof of the property - Examples and Practice Questions d. Properties of Discrete Time Fourier Transform (DTFT) - Correlation property - Proof of the property - Examples and Practice Questions e. Properties of Discrete Time Fourier Transform (DTFT) - Parseval's Theorem - Proof of the property - Examples and Practice Questions f. Properties of Discrete Time Fourier Transform (DTFT) - Symmetry property - Proof of the property - Examples and Practice Questions

	3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Fourier Series and transform https://www.khanacademy.org/science/electrical-engineering/ee-signals ▪ Digital signal Processing by Salivahanan Pg:279-319 A.Anand Pg:358-398 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. 2. Google form Quiz on Introduction to Properties of DTFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 30	**Course Name: Digital Signal Processing** **Topic: DFT and IDFT**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Discrete Fourier transform b. Illustrate the performance of FT, DTFT and DFT
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What are discrete signals? - Difference between FT and DFT 2. **Development** (30 minutes) a. Discrete Fourier Transform (DFT) - Definition - Mathematical expression - Examples and Practice Questions b. Inverse Discrete Fourier Transform (IDFT) - Definition - Mathematical expression

	- Examples and Practice Questions c. Discrete Fourier Transform of finite length impulse sequence - Proof of the function - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Fourier Series and transform https://www.khanacademy.org/science/electrical-engineering/ee-signals ▪ Digital signal Processing by J.Proakis- Pg:394-406, 409-425 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). 2. Allow students to answer and discuss on Introduction to DFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 31	**Course Name: Digital Signal Processing** **Topic: Properties of DFT-I**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of n-point Discrete Fourier transform b. Illustrate the performance of DFT
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What are discrete signals? - Difference between FT, DTFT and DFT 2. **Development** (30 minutes) a. Twiddle factor - Concept of Twiddle factor - 4-point DFT - 8-point DFT

	- DFT matrix - Examples and Practice Questions b. Properties of Discrete Fourier Transform - Periodicity property of DFT - Proof of periodicity property - Examples and Practice Questions c. Properties of Discrete Fourier Transform - Linearity property of DFT - Proof of Linearity property - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ DFT https://youtu.be/d5GMl4-KGQQ ▪ Digital signal Processing by J.Proakis- Pg:394-406, 409-425 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss on Introduction to property of DFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 32	**Course Name: Digital Signal Processing** **Topic: Properties of DFT-I**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of property of Discrete Fourier transform b. Illustrate the performance of DFT
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What are the twiddle factors? - What is periodicity of a function

	2. **Development** (30 minutes) a. Properties of Discrete Fourier Transform - Time reversal property of DFT - Proof of time reversal property - Examples and Practice Questions b. Properties of Discrete Fourier Transform - Circular time shift property of DFT - Proof of the property - Examples and Practice Questions c. Properties of Discrete Fourier Transform - Circular frequency shift property of DFT - Proof of the property - Examples and Practice Questions d. Properties of Discrete Fourier Transform - Multiplication of two sequences of DFT - Proof of the property - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ DFT https://youtu.be/d5GMl4-KGQQ ▪ Digital signal Processing by J.Proakis- Pg:394-406, 409-425 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss on Introduction to property of DFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 33	**Course Name: Digital Signal Processing** **Topic: Circular Convolution, Twiddle factor**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of circular convolution b. Illustrate the performance of sequences
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask question - What are the twiddle factor? - What is periodicity of a function 2. **Development** (30 minutes) a. Linear Convolution (Revision) - Graphical Method - Tabular Method - Matrix Method - Sum by column Method - Overlap- add Method - Examples and Practice Questions b. Circular Convolution (Introduction) - Graphical Method - Tabular Method - Matrix Method - Overlap- add Method c. Circular Convolution-Graphical Method - Circular representation of shifted signal - Circular representation of flipped signal - Examples and Practice Questions 3. **Exercise** (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Circular Convolution https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-10-circular-convolution/ ▪ Digital signal Processing by Salivahanan Pg:283-290

	A.Anand Pg:444-452 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss on convolution. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 34	**Course Name: Digital Signal Processing** **Topic: Circular Convolution**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of circular convolution b. Illustrate the performance of sequences
Teaching Aids (if any)	a. PowerPoint presentation b. Tutorial sheet
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What are the twiddle factor? - What is periodicity of a function 2. **Development** (30 minutes) a. Circular Convolution (Introduction) - Graphical Method - Tabular Method - Matrix Method - Overlap- add Method b. Circular Convolution-Matrix Method - Convolution of two signals using matrix method - Examples and Practice Questions c. Circular Convolution- Tabular Method - Convolution of two signals using tabular method - Examples and Practice Questions d. Circular Convolution-Overlap-add Method - Convolution of two signals using overlap-add method - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Quiz

Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Circular Convolution https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/video-lectures/lecture-10-circular-convolution/ ▪ Digital signal Processing by Salivahanan Pg:283-290 A.Anand Pg:444-452 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss on convolution. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 35	**Course Name: Digital Signal Processing** **Topic: Fast Fourier Transform**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Fast Fourier transform b. Illustrate the performance of sequences
Teaching Aids (if any)	a. PowerPoint presentation b. Tutorial Sheet
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What is linearity of a function? - What is periodicity of a function 2. **Development** (30 minutes) a. Fast Fourier Transform (FFT) - Definition - Approach - Examples and Practice Questions b. Type of FFT - Decimation in time (DIT) FFT algorithm - Decimation in frequency (DIF) FFT algorithm c. FFT using Twiddle factor - Analysis of the method

	- Examples and Practice Questions 3. Exercise (5 minutes) – Activity: Numerical Practice
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ FFT https://www.youtube.com/watch?v=OL1SvTWmg80 ▪ Digital signal Processing by J.Proakis- Pg:448-457 Salivahanan Pg:319-322 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss on FFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 36	**Course Name: Digital Signal Processing** **Topic: DIT-FFT**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Fast Fourier transform b. Illustrate the performance of sequences
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What is linearity of a function? - What is periodicity of a function 2. **Development** (30 minutes) a. Type of FFT - Decimation in time (DIT) FFT algorithm - Decimation in frequency (DIF) FFT algorithm b. FFT using signal flow graph - Butterfly Diagram - Flow graph of radix-2 DIT FFT - Flow graph of radix-4 DIT FFT

	- Flow graph of radix-8 DIT FFT 3. Exercise (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ FFT https://www.youtube.com/watch?v=OL1SvTWmg80 ▪ Digital signal Processing by J.Proakis- Pg:457-461 Salivahanan Pg:322-327 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss on FFT. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 37	**Course Name: Digital Signal Processing** **Topic: DIT- FFT**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of Fast Fourier transform b. Illustrate the performance of sequences
Teaching Aids (if any)	a. PowerPoint presentation b. Examples
Teaching Development	1. **Introduction** (5 minutes) Ask questions - What is the linearity of a function? - What is periodicity of a function 2. **Development** (30 minutes) a. FFT using signal flow graph - Butterfly Diagram - Flow graph of radix-2 DIT FFT - Flow graph of radix-4 DIT FFT - Flow graph of radix-8 DIT FFT b. Decimation in time FFT algorithms

	- Computational consideration. - Signal flow graph/Butterfly diagram - Examples and Practice Questions c. Decimation in frequency FFT algorithms - Computational consideration. - Signal flow graph/Butterfly diagram - Examples and Practice Questions 3. Exercise (5 minutes) – Activity: One minute paper
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ FFT https://www.youtube.com/watch?v=OL1SvTWmg80 ▪ Digital signal Processing by J.Proakis- Pg:462-471 Salivahanan Pg:327-344 A.Anand Pg:479-524 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 38	**Course Name: Digital Signal Processing** **Topic: Introduction to digital filters**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of designing of Digital filters b. Illustrate the performance of Digital filters
Teaching Aids (if any)	a. PowerPoint presentation
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you mean by a filter? - What is difference between analog filter and digital filter. 2. **Development** (30 minutes)

	a. Analog filters - Low pass filter - High pass filter - Band pass filter - Band reject filter - All pass filter b. Digital filters - IIR filters - FIR filters c. Digital filters - Comparison of Analog filter and Digital filters - Advantages of Digital filters - Disadvantages of Digital filters - Applications 3. Exercise (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Digital Filters **Nptel Link** :- https://www.analog.com/media/en/technical-documentation/dsp- book/dsp_book_Ch14.pdf ▪ Digital signal Processing by Salivahanan Pg: Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 39	**Course Name: Digital Signal Processing** **Topic: Introduction to FIR filters**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Outline the characteristics of practical frequency-selective filters. b. Identify the types of FIR filters.

Teaching Aids (if any)	a. PowerPoint presentation on FIR filters. b. Examples of practical applications of FIR filters.
Teaching Development	1. **Introduction** (5 minutes) Ask questions - Define FIR filters. - Discuss the importance of frequency-selective filters in signal processing. 2. **Development** (30 minutes) a. Characteristics of practical filters - Linear phase property of FIR filters and its significance in applications requiring phase accuracy. - Stability of FIR filters due to their non-recursive nature. - delay and computational complexity in FIR filters. b. Typres of FIR filters - low-pass - high-pass - band-pass - band-stop - Examples and Practice Questions c. FIR Filters in Practice - real-world applications - Comparison of FIR filters. 3. Exercise (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ FFT https://www.youtube.com/watch?v=OL1SvTWmg80 ▪ Digital signal Processing by J.Proakis- Pg:462-471 Salivahanan Pg:327-344 A.Anand Pg:479-524 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions (What, Why, Who?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 40	Course Name: Digital Signal Processing Topic: FIR filter design specifications	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. Model filter design specifications like peak pass band ripple and minimum stop band attenuation.
Teaching Aids (if any)	a. PowerPoint presentation b. Design specification tables for various FIR filters.
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you mean by a filter? - Discuss the importance of filter specifications. 2. **Development** (30 minutes) a. Key specification of filters - peak pass band ripple - minimum stop band attenuation - transition band width. b. Impact of filter performance - Demonstrate using MATLAB altering each specification changes the filter's performance. - Practical examples 3. Exercise (5 minutes) – Activity: Quiz
Closure	a. Summarize the significance of specifications in FIR filter design Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: Why are design specifications critical in FIR filter design? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 41	Course Name: Digital Signal Processing Topic: Design of FIR filter using Windowing method	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. Model the windowing method for designing FIR filters. b. Learn how to apply different window functions.
Teaching Aids (if any)	a. PowerPoint presentation b. MATLAB demonstration of FIR filter design using the windowing method.
Teaching Development	1. **Introduction** (5 minutes) Ask question - Discuss the importance of filter specifications. Brief introduction of the windowing method as a popular technique for FIR filter design. 2. **Development** (30 minutes) a. Overview of window function - Introduce the concept of windowing and its role in FIR filter design. - Discuss common window functions: Rectangular, Hamming, Hanning, and Blackman. - Explain how each window function affects the frequency response, focusing on the trade-off between main lobe width and side lobe level. b. FIR Filter Design using Windowing - Demonstrate how to apply a chosen window function to a filter design using MATLAB. - Compare the frequency response of FIR filters designed with different windows, emphasizing the differences in performance 3. **Exercise** (5 minutes) – Activity: Group discussion
Closure	a. Summarize the key points of the windowing method and how different windows can tailor a filter's performance to specific needs. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How does the choice of window function affect FIR filter performance? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 42	Course Name: Digital Signal Processing Topic: FIR filter design using Frequency Sampling Method	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. Learn the frequency sampling method for FIR filter design. b. Apply this method to design FIR filters.
Teaching Aids (if any)	a. Frequency sampling method examples PowerPoint presentation b. MATLAB examples of FIR filters designed using the frequency sampling method.
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you mean by a filter? - Explain the concept of sampling the desired frequency response at specific points Brief overview of the frequency sampling method. 2. **Development** (30 minutes) a. Frequency Sampling Method - Mathematical basis of the frequency sampling method. - Choose sampling points - Examples of frequency b. Practical design - Demonstration of designing an FIR filter using the frequency sampling method. - Using MATLAB, selecting the sampling points and constructing the filter. - Comparison of frequency response of a filter designed using this method to one designed using windowing - Limitations of the frequency sampling method 3. Exercise (5 minutes) – Activity: Summarizing
Closure	a. Recap the frequency sampling method and its significance in FIR filter design. b. Discuss when and why this method would be preferred over others. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Question: "What are the key advantages and potential pitfalls of using the frequency sampling method in FIR filter design?"

	2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 43	Course Name: Digital Signal Processing Topic: Introduction to IIR filters	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. Differentiate between FIR and IIR filters. b. Outline the basic characteristics of IIR filters
Teaching Aids (if any)	a. PowerPoint presentation b. Comparative diagrams of FIR and IIR filters.
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you mean by a FIR filter? - Discuss the importance of FIR filter specifications. Brief overview of IIR filters and compare them with FIR filters. 2. **Development** (30 minutes) a. Characteristics of IIR filters - Infinite Impulse response - Stability - Phase distortion b. Introduction to IIR filter methods - By approximation of derivatives - Impulse Invariant transformation - Bilinear Transformation method 3. Exercise (5 minutes) – Activity: Visible Quiz
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Digital Filters **Nptel Link** :- https://www.analog.com/media/en/technical-documentation/dsp- book/dsp_book_Ch14.pdf ▪ Digital signal Processing by A.Anand Kumar Pg: 551- 580

	Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How do IIR filters differ from FIR filters? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 44	**Course Name: Digital Signal Processing** **Topic: Design of IIR filters from Analog filter**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Model the process of designing IIR filters from analog prototypes.
Teaching Aids (if any)	a. PowerPoint presentation b. Examples of analog filter designs.
Teaching Development	1. **Introduction** (5 minutes) Ask question - Explain the frequency sampling process - Discuss the importance of filter specifications. Brief overview of analog to digital filter conversion. 2. **Development** (30 minutes) a. Standard analog filters - Butterworth - Chebyshev - Elliptic filters b. Bilinear Transformation method - maps the s-plane (analog) to the z-plane - filter's stability - frequency response characteristics. - frequency warping

	c. Impulse Invariant transformation - Sampling the impulse response of an analog filter to create a corresponding digital filter. - advantages and limitations of aliasing issues in the frequency domain. d. Comparison of methods 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the Lesson Learning Outcomes and get affirmation from students on these. b. Suggested Reading ▪ Digital Filters **Nptel Link** :- https://www.analog.com/media/en/technical-documentation/dsp- book/dsp_book_Ch14.pdf ▪ Digital signal Processing by A.Anand Kumar Pg: 551- 580 Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: What are the steps involved in designing IIR filters from analog filters? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 45	**Course Name: Digital Signal Processing** **Topic: Impulse Invariance Method for IIR Filter Design**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Learn how to design IIR filters using the impulse invariance method. b. Explain the underlying principles and practical applications of this method in digital signal processing.
Teaching Aids (if any)	a. PowerPoint presentation b. MATLAB demonstration of the impulse invariance method.
Teaching Development	1. **Introduction** (5 minutes) Ask question

	- What do you mean by a IIR filter? - Discuss the importance of different filters. 2. **Development** (30 minutes) a. Concept of Impulse Response Digital filters - Dirac delta function. - Discuss how sampling this impulse response is central to the impulse invariance method. b. Sampling the analog filter - impulse response at discrete intervals - translating it to the z-domain - constructing the corresponding IIR filter. c. Practical Examples - analog filter's impulse response is sampled and used to create an IIR filter - Compare the frequency responses of the original analog filter and the digital 3. Exercise (5 minutes) – Activity: Summarizing
Closure	a. Summarize the key steps and concepts involved in the impulse invariance method, emphasizing its use in preserving the time-domain characteristics of the original analog filter Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions What are the limitations of the impulse invariance method, and how might they impact the design of digital filters. 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 46	**Course Name: Digital Signal Processing** **Topic: Bilinear Transformation Method for IIR Filter Design**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Explain the principles behind the bilinear Z transformation method for designing Infinite Impulse Response (IIR) filters. b. Learn how to apply the bilinear Z transformation to convert analog filter designs into digital IIR filters.

Teaching Aids (if any)	a. PowerPoint presentation b. Example problems on bilinear Z transformation.
Teaching Development	1. **Introduction** (5 minutes) Ask question - What is the difference between analog and digital filter? - What is the difference between FIR and IIR filters Brief overview of bilinear transformation method 2. **Development** (30 minutes) a. Overview of bilinear transformation method - Mapping of s- plane to z-plane - Importance of frequency warping b. Mathematical foundation - Mathematical basis of the bilinear transformation - Mapping c. Significance of filter design - Importance of bilinear transformation in digital filter designs - its ability to avoid aliasing, - stability of the analog filter when converted to digital form. 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Recap the key steps in the bilinear Z transformation process, emphasizing its advantages, such as avoiding aliasing and preserving filter stability. b. Highlight the importance of frequency pre-warping and how it ensures the digital filter meets the desired design criteria. c. Discuss real-world applications where the bilinear Z transformation is particularly useful, such as in audio processing and communication systems. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How does the bilinear Z transformation help in IIR filter design, and what are its key advantages compared to other methods 2. encourage students to reflect on the method's strengths and any potential challenges. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 47	Course Name: Digital Signal Processing Topic: QMF Filter Design	Course No.: ECE-502

Objectives	At the end of the lesson the student shall be able to: a. Outline the concept and design of Quadrature Mirror Filters (QMF).
Teaching Aids (if any)	a. PowerPoint presentation b. Design examples of QMF filters
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you mean by a filter? - How does the bilinear Z transformation help in IIR filter design? 2. **Development** (30 minutes) a. QMF Filters and Their Applications - Quadrature Mirror Filters and its role in digital signal processing. - Describe how QMF filters are used to split a signal into two frequency bands - Highlighting the primary applications of QMF filters, b. QMF Structure and Design - QMF Filter Banks - Perfect Reconstruction - Delay and scaling factor. c. Designing QMF Filters - Design process of a basic QMF filter bank - Quadrature mirror:flipping and modulating method - Significance in Multirate Signal Processing 3. Exercise (5 minutes) – Activity: One minute paper
Closure	a. Summarize the key aspects of QMF filters, including their structure, design principles, and importance in digital signal processing. b. Applications Review: Briefly revisit the applications of QMF filters c. Encourage students to think about how QMF filters relate to other filter design techniques they have studied, such as FIR and IIR filters, and the unique advantages QMF offers in specific applications.

	Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: What are the primary applications of QMF filters, and why are they important in multirate signal processing? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 48	**Course Name: Digital Signal Processing** **Topic: Introduction to Butterworth Filters**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Outline the characteristics of Butterworth filters. b. Learn how to design Butterworth filters.
Teaching Aids (if any)	a. PowerPoint presentation b. Butterworth filter design examples
Teaching Development	1. **Introduction** (5 minutes) Ask question - What do you mean by a filter? - Discuss the importance of filter specifications. Brief overview of Butterworth filter. 2. **Development** (30 minutes) a. Flat Passband Characteristics of Butterworth - Mathematical foundation - Frequency response graph - Tradeoff: Flat bandwidth vs slow roll-off b. Designing Low-Pass and High-Pass Butterworth Filters - Low-Pass Filter Design - High-Pass Filter Design - Example Calculations 3. **Exercise** (5 minutes) – Activity: Summarizing

Closure	a. Recap the key steps in designing a Butterworth filter, including determining the cutoff frequency, choosing the filter order, and calculating the transfer function. b. Emphasize the importance of understanding the trade-offs, such as the balance between flat passband and the rate of roll-off. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: Ask students to reflect on what makes Butterworth filters unique compared to other filter types. 2. Encourage them to consider the implications of the flat passband and how this characteristic influences their decision to use Butterworth filters in various applications. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No.49	**Course Name: Digital Signal Processing** **Topic: Chebyshev Analog Filters**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Learn the characteristics of Chebyshev filters. b. Explain the design process of Chebyshev filters.
Teaching Aids (if any)	a. PowerPoint presentation b. Examples of Chebyshev filter designs
Teaching Development	1. **Introduction** (5 minutes). Ask question - Name different analog filters and explain its principle. - What is difference between IIR filter and FIR filter? 2. **Development** (30 minutes) a. Introduction to Chebyshev Filters - Types: Chebyshev Type I and Chebyshev Type II filters -Applications of Chebyshev Type b. Ripple Characteristics in the Passband of Chebyshev Filters - Concept of Ripple - Mathematical expression for the transfer function - Frequency response graphs of a Chebyshev Type I filter. - Compare these graphs with those of Butterworth filters, emphasizing the sharper roll-off at the expense of passband ripple. c. Design of Chebyshev Filters and Comparison with

	Butterworth Filters - Parameters: filter order, cutoff frequency, and the allowable ripple level. - Compare these graphs with those of Butterworth filters, emphasizing the sharper roll-off at the expense of passband ripple. 3. **Exercise** (5 minutes) – Activity: Summarizing
Closure	a. Summarize the key characteristics: sharp roll-off, controlled ripple in the passband (Type I) or stopband (Type II), and the implications of these features. b. Encourage students to think about when to use Chebyshev filters in real-world applications. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How does the passband ripple affect the performance of Chebyshev filters? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 50	**Course Name: Digital Signal Processing** **Topic: Comparison of FIR and IIR Filters**	**Course No.: ECE-502**

Objectives	At the end of the lesson the student shall be able to: a. Compare the characteristics, advantages, and disadvantages of FIR (Finite Impulse Response) and IIR (Infinite Impulse Response) filters.
Teaching Aids (if any)	a. Use of Google form tool for online quiz b. PowerPoint presentation c. Comparative Charts and Graphs
Teaching Development	1. **Introduction** (5 minutes) Ask question - Define FIR Filters - Define IIR Filters - Highlight common applications of each type of filter in digital signal processing, such as audio processing, communications, and control systems. 2. **Development** (30 minutes)

	a. Differences in Terms of Phase - Phase Response of FIR Filters - Phase Response of IIR Filters - Compare the phase characteristics of FIR and IIR filters b. Other Key Differences - Computational Complexity - Stability and Implementation - Frequency response 3. Exercise (5 minutes) – Activity: Design Comparison Task
Closure	a. Summarize the main points discussed: phase response, computational complexity, stability, and implementation differences between FIR and IIR filters. b. Emphasize the scenarios where one type of filter might be preferred over the other based on the application's requirements. Spend 5 minutes to wrap up and consolidate the learning
Evaluation	1. Reflective Questions: How does the choice between FIR and IIR filters affect the performance of their systems? 2. Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents