Course VI	Elective - PHYE223
Title of the Course:	**Digital Signal and Image Processing**
Credits:	**2-1-0-3**
Pre-requisites, if any:	M. Sc., Physics, Theoretical Physics, Material Science and Nanoscience
Course Objectives	1. To state the fundamentals of signal processing concepts employed in physical sciences applications. 2. To explain important signal processing algorithms and their applications. 3. To identify specific filtering techniques for reducing several noises and artifacts. 4. To enumerate the basics of image formation and image reconstruction. 5. To outline simple image processing methods to solve problems encountered in imaging instruments.
Course Outcomes	**The student will be able** 1. To define the basics, mathematical representation, and classification of discrete-time signals and systems. 2. To identify, select and apply appropriate signal processing techniques to analyze signals for specific real-world applications. 3. To differentiate the intricacies in selecting a filter for a specific application. 4. To conceptualize ideas about image formation and reconstruction 5. To evaluate the salient features of image processing techniques in improving the quality of physical images.
Units	
I	**Discrete Time Signal and Systems:** Basics of signals – period, frequency, phase - a mathematical representation of signals - discrete-time signals - data acquisition – sequences – linear shift-invariant systems – stability and causality – linear constant coefficient difference equations – frequency domain – representation of discrete-time systems and signals – representation of discrete-time signals by Fourier transform.
II	**Transform Analysis:** Linear time Invariant systems - Discrete Fourier Transform – computation of DFT – decimation in time FFT and Frequency -Signal Analysis methods: Time and frequency domain analysis – STFT– wavelet - Z-transform – the region of convergence – relation between Z-transform and Fourier transform.
III	**Filter Design Techniques:** Signal noise – inherent noise, EMI noise, random noise, speckle noise, process induced noises, etc. — basic digital filter structures – FIR and IIR filters design of FIR filters by window method – rectangle – Hanning, Hamming – Kaiser – IIR filters design – bilinear transformation.
VI	**Digital Image Characterization**: Light perception – eye physiology – visual phenomena – monochrome vision model – 2D-image sampling & reconstruction – image sampling systems – aliasing effects - Image representation – 2D-systems – 2D-Fourier Transform — image reconstruction systems – vector-space image representation – image quantization.

V	**Image Processing:** Image Enhancement - Introduction to image representation – spatial and frequency domain – generalized 2D linear operator – superposition – filtering - convolution and de-convolution – unitary transformations – Fourier transform – cosine transformation – image reconstruction and enhancement – contrast manipulation – histogram modification – noise-cleaning – image analysis – edge detection – contour quantification – texture analysis – statistical analysis.
Reading List (Print and Online)	1. Richard G. Lyons, "Understanding Digital Signal Processing," Addison Wesley, 1999. 2. Alan V. Oppenheim, Ronald W. Schafer, "Digital Signal Processing", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999. 3. Ralph Chassaing, DSP Applications Using C and the TMS320C6x DS, ISBN: 0-471-207 4. L. R. Rabiner and B. Gold, Theory and Applications of Digital Signal Processing, Prentice-Hall of India. 5. T. Bose, Digital Signal and Image Processing, 1st edition, John Wiley (2003).
Recommended Texts	1. William K. Pratt, Digital Image Processing, 3rd edition, John Wiley & Sons, Inc., USA (2001). 2. Alan V. Oppenheim and Ronald W. Schafer, Digital Signal Processing, New Delhi (2000). 3. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Third Edition, PHI, 2000. 4. Sanjit K. Mitra, Digital Signal Processing: A Computer-Based Approach, McGraw Hill, 2000, 2nd Edition. 5. Steven W Smith, The Scientist and Engineer's Guide to Digital Signal Processing, California Technical Publishing, 1999. 6. S. Salivahanan, A Vallavaraj and C Gnanapriya, Digital Signal Processing, Second Edition, TMH Publishing Company Ltd., New Delhi, 2001.
Online resources	1. www.techonline.com 2. www.ti.com 3. www.dspvillage.com 4. www.adi.com 5. www.dspguru.com 6. www.en.wikipedia.org/wiki/digital_signal_processing.html 7. www.dsptutor.freeuk.com 8. www.dspguide.com

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites, etc.]
https://nptel.ac.in/courses/108/106/108106151/
https://nptel.ac.in/courses/108/101/108101174/
https://nptel.ac.in/courses/108/106/108106168/
https://nptel.ac.in/courses/117/105/117105135/
https://nptel.ac.in/courses/106/105/106105032/
https://nptel.ac.in/courses/117/104/117104069/
https://nptel.ac.in/courses/117/105/117105079/

Method of Evaluation:

Sessional I	Sessional II	End Semester Examination	Total	Grade
20	20	60	100	

Methods of assessment:
Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3) - Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4) - Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6) - Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	S	L	S	L	L	M	S	L	M	S
CO 2	S	L	S	L	L	M	S	L	M	S
CO 3	S	L	S	L	L	M	S	L	M	S
CO 4	S	L	S	L	L	M	S	L	M	S
CO 5	S	L	S	L	L	M	S	L	M	S