# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Branch: Electronics & Communication (Signal Processing Technology)**

**Course / Subject Code : ME01026031**

**Course / Subject Name : Wavelet Transform and Applications**

| | |
|---|---|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 1st Semester |
| Category of the Course: | PEC |

| | |
|---|---|
| **Prerequisite:** | Understanding of discrete time signals and systems, Fourier Transform |
| **Rationale:** | Wavelet has established itself as an important tool in modern signal processing as well as in applied mathematics. Students of ME in Signal Processing must acquire fundamental concepts of advanced Signal Processing and its applications. Students also must understand theory and importance of wavelet transform for signal processing applications. |

**Course Outcome:**

After Completion of the Course, Student will able to:

| No | Course Outcomes | RBT Level |
|---|---|---|
| 01 | Classify various wavelet transform and explain importance of it. | **U** |
| 02 | Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT). | **U** |
| 03 | Explain the properties and application of wavelet transform. | **U** |
| 04 | Develop and realize computationally efficient wavelet based algorithms for signal and image processing. | **C** |
| 05 | Explain brief features and strength of transform beyond wavelet. | **U** |

**Revised Bloom's Taxonomy (RBT)*

**Teaching and Examination Scheme:**

| Teaching Scheme (in Hours) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial / Practical | | |
| L | T | PR | C | ESE (E) | PA / CA (M) | PA/CA (I) | ESE (V) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 20 | 30 | 150 |

# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Branch: Electronics & Communication (Signal Processing Technology)**

**Course / Subject Code : ME01026031**

**Course / Subject Name : Wavelet Transform and Applications**

**Course Content:**

| Unit No. | Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 1. | **Introduction:** • Origin of wavelets and its history • Different communities of wavelet • Classification: continuous and discrete wavelet transforms • Developments in wavelet theory applications | 6 | 14 |
| 2. | **Continuous Wavelet Transform**: • Introduction • Continuous time wavelets • Definition of CWT • Constant Q factor filtering interpretation and Time Frequency Resolution • CWT as an operator • Inverse CWT | 7 | 14 |
| 3. | **Introduction to the Discrete Wavelet Transform and orthogonal Wavelet decomposition**: • Approximations of vectors in nested linear vector subspaces • Multi-resolution Analysis of L2 (R) • Haar Scaling function • Haar wavelet • Haar wavelet decomposition. • Haar wavelet packets and application. | 7 | 17 |
| 4. | **MRA Ortho-normal wavelets and their relationships to filter banks**: • Construction of an ortho-normal MRA • Wavelet basis for the MRA • Digital filtering interpretation • Examples of orthogonal basis generating wavelets • Interpreting ortho-normal MRA for discrete time signals • Generating scaling functions and wavelets from filter coefficients. | 6 | 12 |
| 5. | **Bi-orthogonal Wavelets**: • Bi-orthogonal Wavelet bases • Filtering relationship for Bi-orthogonal filters • Bi-orthogonal scaling functions and wavelets • Two dimensional wavelets • Non separable Multi-dimensional wavelets • Wavelet Packets. | 6 | 14 |
| 6. | **Wavelength Transform and applications**: • Transform coding • DTWT for image compression, audio compression • Wavelet based audio coding, video coding and multi resolution Techniques • Wavelet de-noising, Speckle removal, Edge detection and object isolation • Image fusion, Object detection, discrete wavelet multi-tone modulation. | 8 | 19 |
| 7. | **Beyond Wavelet**: • Ridge lets and curve lets: Ridge let transform and Digital Curve let transform • Curve let construction • Properties and applications. | 5 | 10 |
| | **Total** | **45** | **100** |

# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Master of Engineering**

**Level: PG**

**Branch: Electronics & Communication (Signal Processing Technology)**

**Course / Subject Code : ME01026031**

**Course / Subject Name : Wavelet Transform and Applications**

**Suggested Specification Table with Marks (Theory):**

| Distribution of Theory Marks (in %) | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **10** | **20** | **20** | **30** | **10** | **10** |

*Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)*

**References/Suggested Learning Resources:**

**(a) Books:**


1. Raguveer M.Rao and Ajit S. Bopardikar-Wavelet Transforms –Introduction and applicationsPearson Education, 2008
2. K.P Soman, K. I. Ramachandran –Insight into Wavelets from Theory to practice, PHI,2006


**(b) Open source software and website:**

1. MATLAB, Scilab
2. https://nptel.ac.in

**Suggested Course Practical List:**

1. To study various wavelets families.
2. To study Harr wavelets filter banks.
3. To study the Continuous Wavelet Transform: composition and decomposition.
4. To study the Discrete Wavelet Transform: composition and decomposition.
5. To write and verify code for signal/image smoothing using wavelet transform.
6. To write and verify code for signal/image de-noise using wavelet transform.
7. To write and verify code for signal/image compression using wavelet transforms.
8. To write and verify code for signal/image edge detection using wavelet transforms.
9. To write and verify code for signal/image matching using wavelet transforms.
10. To write and verify code for signal/image fusion using wavelet transforms.
11. To study the working principle of Ridge-let transforms.
12. To study the working principle of curve-let transforms.

* * * * * * *