<table>
<thead>
<tr>
<th>1. Course Title</th>
<th><strong>Adaptive Signal Processing</strong></th>
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</thead>
<tbody>
<tr>
<td>2. Credit Structure</td>
<td>Lecture hours per week: 3</td>
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<td></td>
<td>Tutorial hours per week: 0</td>
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<td>Practical hours per week:0</td>
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<td>Total Credits:3</td>
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<td>3. Course Code</td>
<td>CT 477</td>
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<td>4. Program/Semester</td>
<td>Technical Elective open to MTech</td>
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<td>5. Category</td>
<td>Core / Group core / Technical Elective / Open Elective / Science Elective</td>
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<tr>
<td>6. Prerequisite courses</td>
<td>Signal Processing</td>
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<td>7. Foundation for</td>
<td>-</td>
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<tr>
<td>8. Abstract Content</td>
<td>Introduction to Adaptive Filters, Stochastic Processes, Wiener Filters, Steepest Descent Technique, Least-Mean-Square Adaptive Filters, Other LMS-Based Adaptive Filters, Sparse Adaptive Filters, Recursive Least Square Adaptive Filters, Kalman Filters and Blind Decovolution.</td>
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<tr>
<td>Topic Name</td>
<td>Content (2 -3 lines per 4 – 6 lectures)</td>
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| **Introduction to Adaptive Filters** | • Brief discussion on digital filters.  
  • An overview of adaptive filters.  
  • Applications of adaptive filters.                               | 3              |
| **Stochastic Processes**          | • Introduction to random variables, discrete time stochastic process.  
  • Correlation matrix.  
  • Auto regressive process.  
  • Power spectral density and power spectrum estimation.                                            | 4              |
| **Wiener Filters**                | • Linear optimum filtering.  
  • Wiener-Hopf equations.  
  • Linearly constrained minimum-variance filter.                                                   | 3              |
| **Steepest Descent Technique**    | • Basic idea of the steepest descent algorithm.  
  • Stability of the steepest descent algorithm.  
  • Newton’s algorithm.                                                                           | 3              |
| **Least-Mean-Square Adaptive Filters** | • Least-mean-square (LMS) algorithm.  
  • Stability of the LMS algorithm.  
  • Sign LMS algorithm.  
  • Variable step size LMS algorithm.                                                               | 6              |
| **Other LMS-Based Adaptive Filters** | • Normalized LMS (NLMS) algorithm.  
  • Affine projection algorithm (APA).  
  • Set-membership affine projection algorithm.                                                      | 5              |
| **Sparse Adaptive Filters**       | • Proportionate NLMS (PNLMS) algorithm.  
  • Zero attracting NLMS (ZA-NLMS) algorithm.  
  • Zero attracting PNLS (ZA-PNLMS) algorithm.                                                      | 5              |
| **Recursive Least Square Adaptive Filters** | • Matrix inversion lemma.  
  • Exponentially weighted recursive least square (RLS) algorithm.  
  • Convergence analysis of the RLS algorithm.                                                      | 3              |
| **Kalman Filters**                | • Innovation process.  
  • Estimation of the states using the innovation                                                   | 3              |
## Blind Deconvolution

- An introduction to blind deconvolution or blind equalizer.
- Bussgang algorithm for blind equalization.
- Fractionally spaced Bussgang equalizers.

### Outcomes and Objectives

By the end of this course, the student should be able to do the followings:
1. To implement adaptive filters for various applications like echo cancellation and systems or channels identification.
2. To Analyze and implement Wiener filters, LMS, NLMS, APA, PNLMS, ZA-NLMS, ZA-PNLMS, RLS, Kalman Filters and Bussgang equalizers.

### Course Assessment / Evaluation Method (Tentative)

Mid-Sem: 40%
End-Sem: 60%