| Semester-I | | | |
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| **Sr. No** | **Course Code** | **Course** | **L-T-P-C** |
| 1. | EE 634 | Linear Algebra and its applications | 3-0-0-6 |
| 2. | EE 690 | Embedded systems design | 3-0-0-6 |
| 3. | EE 629 | Probability Models and Applications (PMA) | 3-0-0-6 |
| 4. | | Embedded systems design lab or VLSI simulations lab | 0-0-3-3 |
| 5. | EE 420 | Digital communications and coding theory | 2-0-2-6 |
| 6. | EE 621 | Speech Processing | 3-0-0-6 |
| 7. | EE 613 | Speech Processing Laboratory | 0-0-3-3 |

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| 1 | **Title of the course** (L-T-P-C) | **Linear Algebra and its applications** **(3-0-0-6)** |
| 2 | **Pre-requisite courses(s)** | Exposure to Basic calculus. |
| 3 | **Course content** | The following topics will be covered: Vector spaces, linear dependence, basis; Representation of linear transformations with respect to a basis.; Inner product spaces, Hilbert spaces, linear functions; Riesz representation theorem and adjoints.; Orthogonal projections, products of projections, orthogonal direct sums; Unitary and orthogonal transformations, complete orthonormal sets and Parseval's identity; Closed subspaces and the projection theorem for Hilbert spaces.; Polynomials: The algebra of polynomials, matrix polynomials, annihilating polynomials and invariant subspaces, forms, Solution of state equations in linear system theory; Relation between the rational and Jordan forms.; Numerical linear algebra: Direct and iterative methods of solutions of linear equations; Matrices, norms, complete metric spaces and complete normal linear spaces (Banach spaces); Least squares problems (constrained and unconstrained); Eigenvalue problem and SVD. |
| 4 | **Texts/References** | . <br> **2.** K. Hoffman and R. Kunze, Linear Algebra, Prentice-Hall, (1986). <br> **3.** G.H. Golub and C.F. Van Loan, Matrix Computations, Academic, 1983. |

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| 1 | **Title of the course** (L-T-P-C) | **Probability Models and Applications (PMA)** **(3-0-0-6)** |
| 2 | **Pre-requisite courses(s)** | Data analysis and Introduction to probability (6 credits course that all batches are currently doing as core) |
| 3 | **Course content** | **Introduction to** Probability theory.<br><br>**Review of** sample space, events, axioms of probability, introduction to probability as a measure, Random variables, Notion of independence and mutually exclusive events<br><br>Probability Space, limits and sequence of events, continuity of probability, measurable functions, notions of induced measures, connection with cdf, change of measure, conditional probability and conditional expectation, simulating discrete and continuous random variables - accept-reject method, importance sampling.<br><br>**Random vectors and Stochastic processes:** Introduction to random vectors, Gaussian vectors, notion of i.i.d random variables introduction to elementary stochastic processes like Bernoulli process and Poisson process.<br><br>**Markov Process.** Discrete time and continuous time Markov chains**,** classification of states, notion of stationary distribution.<br><br>Simulating stochastic processes like Gaussian process, Poisson process, Markov chains and Brownian motion.<br><br>Introduction to Markov chain monte carlo methods, Hidden Markov chain and Markov decision process, Introduction to Brownian motion and stationary process.<br><br>**Statistics:** MLE, MAP and Bayesian Estimation, sufficient statistics, Cramer-Rao bound |
| 4 | **Texts/References** | **2.** Sheldon Ross “Introduction to probability models” 9th Ed., Elsevier AP<br>**3.** Sheldon Ross, ‘Stochastic process’, John Wiley, 2$^{nd}$ Ed., April 1996.<br>**4.** David Stirzaker, ‘Stochastic process and models’, Oxford press. |

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| 1 | **Title of the course** (L-T-P-C) | **Speech Processing** **(3-0-0-6)** |
| 2 | **Pre-requisite courses(s)** | Exposure to probability concepts. |
| 3 | **Course content** | **Introduction:** Speech production and perception, nature of speech;short-term processing: need, approach, time, frequency and time- frequency analysis.<br><br>**Short-term Fourier transform (STFT):** overview of Fourierrepresentation, non-stationary signals, development of STFT, transform and filter-bank views of STFT.<br><br>**Cepstrum analysis:** Basis and development, delta, delta- delta andmel-cepstrum, homomorphic signal processing, real and complex cepstrum.<br><br>**Linear Prediction (LP) analysis:** Basis and development, Levinson-Durbin's method, normalized error, LP spectrum, LP cepstrum, LP residual.<br><br>**Sinusoidal analysis:** Basis and development, phase unwrapping,sinusoidal analysis and synthesis of speech.<br>**Applications:** Speech recognition, speaker recognition, speech synthesis, language and dialect identification and speech coding. |
| 4 | **Texts/References** | 1. L.R. Rabiner and R.W. Schafer, Digital Processing of SpeechSignals Pearson Education, Delhi, India, 2004<br><br>2. J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Discrete- TimeProcessing of Speech Signals, Wiley-IEEE Press, NY, USA, 1999.<br><br>3. D. O'Shaughnessy, Speech Communications: Human andMachine, Second Edition, University Press, 2005.<br><br>4. T. F. Quatieri, "Discrete time processing of speech signals",Pearson Education, 2005.<br>5. L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana, "Fundamentals of speech recognition", Pearson Education, 2009. |

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| 1 | **Title of the course** (L-T-P-C) | **Speech Processing Laboratory** **(0-0-3-3)** |
| 2 | **Pre-requisite courses(s)** | Currently taking or already taken Speech Processing theory course |
| 3 | **Course content** | The lab will closely follow the theory course. The idea is to have the students implement the basic algorithms on different topics studied in the speech processing theory course. |
| 4 | **Texts/References** | **1.** L.R. Rabiner and R.W. Schafer, Digital Processing of Speech Signals Pearson Education, Delhi, India, 2004<br>**2.** J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Discrete-Time Processing of Speech Signals, Wiley-IEEE Press, NY, USA, 1999.<br>**3.** D. O'Shaughnessy, Speech Communications: Human and Machine, Second Edition, University Press, 2005.<br>**4.** T. F. Quatieri, "Discrete time processing of speech signals", Pearson Education, 2005.<br>**5.** L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana,"Fundamentals of speech recognition", Pearson Education, 2009. |