System Identification deals with the problem of building dynamical models from data. These models could be used for forecasting, prediction, estimation, and feedback control. In this course we will provide a comprehensive treatment of both classical system identification and control-oriented system identification. Numerical, practical, and theoretical aspects will be covered. Topics treated include time and frequency domain methods, generalized parameter estimation, identification of structured non-linear systems, modeling uncertainty bounding, and state-space modeling methods.

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Prerequisites: ME 232 or EECS 221A or consent of instructor
Good MATLAB skills


Course Web Site: http://jagger.berkeley.edu/me290n/

Office Hours: Wednesdays 2:00-4:00pm

Grading Policy: To be determined
Outline:

- **Basic Issues in Modeling:** (2 weeks) Model sets, experiment design, sampling effects, algorithm analysis, bias and variance, identifiability, robustness, convergence and consistency, model verification.

- **Review of Probability Theory:** (2 weeks) Random variables, density and distribution, conditioning, expectation, convergence notions, large number laws, central limit theorem, random processes, stationarity, ergodicity, autocorrelation and power spectral density.

- **Parametric Time-domain Methods:** (3 weeks) Nonlinear programming, Kalman filtering, maximum likelihood estimation, the EM algorithm, generalized LFT-based estimation, prediction-error methods, correlation methods, state-space methods, persistence of excitation.

- **Noise Modelling:** (1 week) Periodograms, estimation of noise statistics, spectral estimation, spectral factorization, time-series analysis.

- **Non-Parametric Frequency-Domain Methods:** (1 week) Spectral methods, empirical transfer-function estimation, windowing methods, convergence aspects.

- **State-space methods for LTI Systems:** (1 week) Subspace methods, relation to the EM algorithm, convergence aspects.

- **Identification of Nonlinear Systems:** (2 weeks) Hammerstien and Weiner models, Interconnected models, Volterra kernels, Dispersion function based identification methods.

- **Other topics:** (1 week) Model validation via correlation, experiment design, model-order selection, Akaike information criterion, the Hannon-Quinn theorem.

- **Control-oriented system Identification:** (2 weeks) Identification in $\mathcal{H}_\infty$, Identification in $\ell_1$, model validation, randomized algorithms.