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| **Adama Science and Technology University**  **School of Electrical Engineering and Computing**  **Department of Electrical Power and Control Engineering** | | | | |
| Course Number | EPCE6402 | | | |
| Course Title | Nonlinear Control System | | | |
| Degree Program | MSc in Electrical Engineering | | | |
| Module | Control Systems Engineering | | | |
| Module Coordinator | N.N. | | | |
| Lecturer | N.N. | | | |
| ECTS Credits | 5 | | | |
| Contact Hours (per week) | Lecture | Tutorial | Practice or Laboratory | Home study |
|  | 3 | 3 | - | - |
| Course Objectives & Competences to be Acquired | 1.Regarding Nonlinear Ordinary Differential Equations (NODE)  -Understand the existence and uniqueness solution to NODE  -Characterize the differences between Linear ODE and NODE  -Understand the various stability definitions such as Lyapunov stability, Exponential Stability, In-out stability  2.Regading Nonlinear System feedback controllers  -Analyze stability the closed loop feedback system using various methods as Passivity, Small-gain theorem, Circle criteria , Popov Criteria and so on  -Design controllers to stabilize Non linear system using Linearization,  Feedback linearization, Backstepping and so on  3. Non –linear stochastic systems (unknown parameter dynamic systems)  - Understand Gaussian Process Model  - Design sub-optimal controllers | | | |
| Course Description/Course Contents | To solve/design control for nonlinear systems, two methods are concurrently lectured and practiced ,analytic method and numerical method.  1. Analytic Method  -.Description about the difference between linear and nonlinear systems  -.Introduction to mathematical tools to analyze nonlinear system features using Lyapunov functions , how to find proper Lyapunov functions  -.To stabilize and track a specific commands, from linearization of nonlinear system, state-feedback linearization to analytic mathematical methods will be introduced. ,  -.Introduce non-linear observers for non-linear state feedback,  -.For the non-parametric systems, introduce model thru Gaussian process.  -.Defined Gaussian Process model, introduce to design controllers to be sub-optimal non-linear controls.  2. Numerical method  -.New matlab toolbox “Chebfun” will follow symbolic math in mathlab to grap out nonlinear systems behaviors. Intensive study will be done by “Chebop”  - Verification the analytical design numerically such as ODE solution, Attracive region, uncertain parameter variations and so on  -.Especially mechanical dynamic system, numerical animation will be introduced to figure out the real system’s behaviors. | | | |
| Pre-requisites | Linear system theory, stochastic process, matlab | | | |
| Semester | First year –II semester | | | |
| Status of Course | Elective | | | |
| Teaching & Learning Methods | Lecture supported by tutorial, assignment | | | |
| Assessment/Evaluation & Grading System | Attendance (10%)  Assignment (30%),  Mid-semester Examination (30%),  Final examination (30%) | | | |
| Attendance Requirements | More than 30% un-attendance should not be allowed to get a normal grade. | | | |
| Literature | *Textbook:*  1.”Nonlinear Control Systems”, by H.K.Khalil, Pearson 3rd edition, 2015  2. “Nonlinear Modelling and control using Gaussian Process”, by A.McHutchon, A thesis for Ph.D,University of Cambridge,2014  *References:*  *1.”Exploring ODE”,L.N.Trefethen, University of Oxford,SIAM, 2018* | | | |