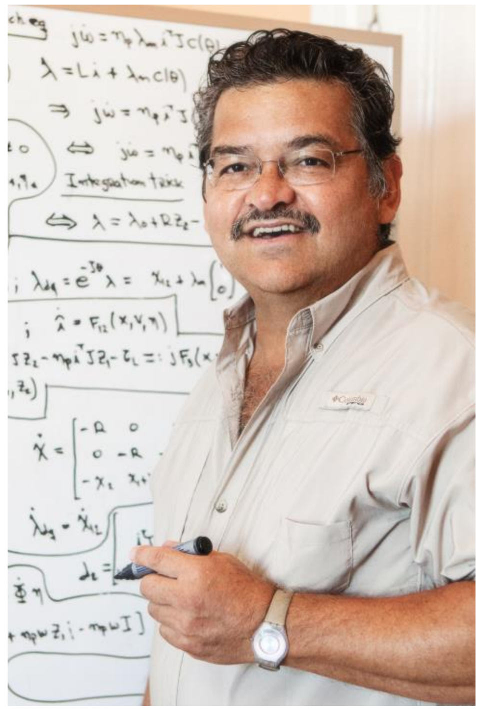
Dr. Romeo Ortega.

Romeo Ortega nació en México. Obtuvo su grado de Ingeniero Mecánico Electricista en la Facultad de Ingeniería de la UNAM, México, su Maestría en Ingeniería en el Instituto Politécnico de Leningrado, URSS, y el grado de Doctor de Estado del Instituto Politécnico de Grenoble, Francia, en 1974, 1978 y 1984, respectivamente.



Trabajó en México en la Facultad de Ingeniería de la UNAM y el CINVESTAV del IPN, hasta 1989. Fue Profesor Visitante en la Universidad de Illinois, EU, en 1987-1988, en la Universidad de McGill en Canadá en 1991-1992 y fue “Fellow" de la Sociedad Japonesa de Promoción de la Ciencia (JSPS) en la Universidad de Sofía, Tokyo, Japón, en 1990-1991. Trabajó como Director de Investigación del Consejo Nacional de Investigación Científica (CNRS) de Francia en el Laboratorio de Señales y Sistemas de Supelec en Gif-sur-Yvette de 1992 a 2020. Actualmente es Profesor de tiempo completo en el ITAM, México.

Sus áreas de investigación son el control no-lineal y adaptable, con énfasis en las aplicaciones ingenieriles.

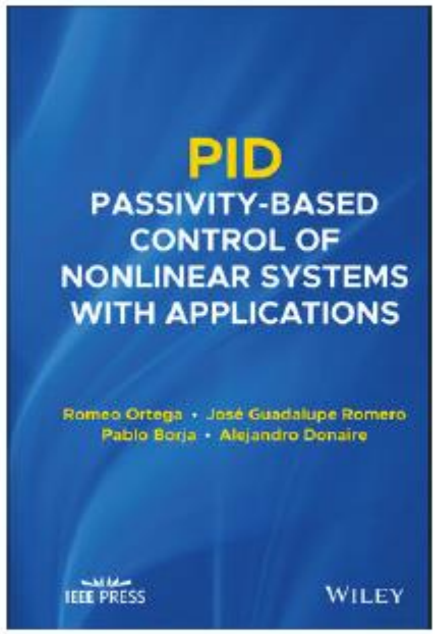
El Dr. Ortega ha publicado 6 libros, más de 375 artículos en revistas científicas internacionales, con un Índice h de 89 en Google Scholar y de 70 en Scopus. Es Miembro Emérito del Sistema Nacional de Investigadores y Miembro Correspondiente de la Academia de Ciencias de México. Es “IEEE Fellow Member" desde 1999 (“life" desde 2020) y “IFAC Fellow" desde 2016. Ha colaborado como “Chairman" en varios comites y conferencias del IFAC y el IEEE, y ha participado en varios cuerpos editoriales de revistas internacionales. Actualmente, es “Editor in Chief" del “Int. J. Adaptive Control and Signal Processing" y “Senior Editor" del “Asian J. of Control”, ambos de Wiley. Su más reciente libro publicado es: PID Passivity-based Control of Nonlinear Systems with Applications, R. Ortega, J. Romero, L. Borja and A. Donaire, J. Wiley and Sons, 2021.

HORARIOS Y TEMAS

1. PID PASSIVITY-BASED CONTROL OF NONLINEAR SYSTEMS WITH APPLICATIONS.

Jueves, 25 de abril

12:00 a 13:30 hrs, y 16:00 a 17:30 hrs**.**



Motivated by current practice, in this course we explore the possibility of applying the industry-standard PID controllers to regulate the behavior of nonlinear systems. As is well-known, PID controllers are highly successful when the main control objective is to drive a given output signal to a constant value. PIDs, however, have two main drawbacks, first, the task of tuning the gains is far from obvious when the systems operating region is large; second, in some practical applications the control objective cannot be captured by the behaviour of output signals. We show that, for a wide class of physical systems, these two difficulties can be overcome exploiting the property of passivity of the system.

Passivity is a fundamental property of dynamical systems, which in the case of physical systems captures the universal feature of energy conservation. It is well-known that PID controllers are passive systems—for all positive PID gains—and that the feedback interconnection of two passive systems is stable. Therefore, wrapping the PID around a passive output trivialises the gain tuning task. Clearly, the first step in the design is to identify all passive outputs of the system. It turns out that this task is achievable for a large class of physical systems described by port-Hamiltonian models.

In many applications the desired values for the outputs are different from zero, whence the PID is wrapped around the error signal. In this case, it is necessary to investigate whether the system is passive with respect to this error signal—a property called shifted passivity, which is also studied in the course.

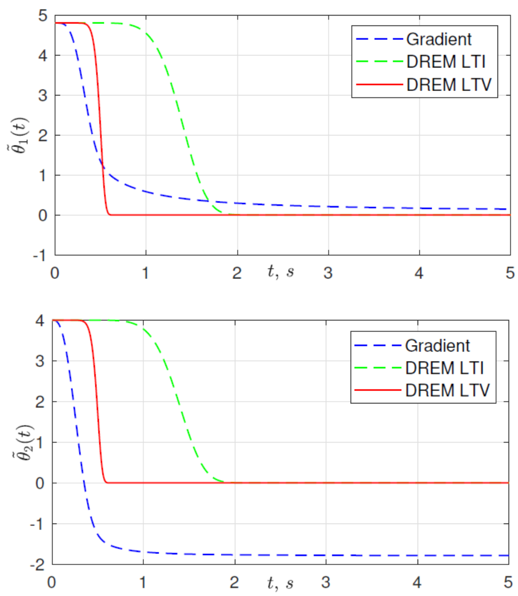
If the control objective is to stabilize (in the Lyapunov sense) a constant equilibrium it is necessary to build a Lyapunov function. In the course we identify—via some easily verifiable integrability conditions—a class of systems for which this more ambitious objective is achieved.

Many mechanical and electrical systems practical applications where PID-PBC is successful are studied in the course. Among them we cite: robots, power systems, power electronic converters, micro-electromechanical devices, levitated systems, fuel-cells systems and motors. In view of this wide range of applications, besides control theorists, the course may be of interest to practitioners working on these fields and to people from industry.

Depending on the amount of detail requested for the theoretical proofs, as well as the application examples, the material can be covered in 6-16hrs. The course can be evaluated requesting reports on some of the material covered in the course.

2. NEW ROBUST PARAMETER ESTIMATORS AND SYSTEMS REPARAMETERIZATIONS: DEALING WITH LACK OF EXCITATION AND NONLINEAR PARAMETERIZATIONS.

Viernes, 26 de abril
12:00 a 13:30 hrs.



In this talk we present some recent results on (i) robust parameter estimation without persistent excitation (PE) and (ii) new reparameterizations of nonlinearly parameterized (NLP) systems. After discussing the motivation to relax the PE assumption, we show how the recently introduced dynamic regressor extension and mixing estimator (DREM) achieves this objective. Moreover, it allows us to consider, separable, NLP that satisfy an easily verifiable monotonizability property and improves, in a quantitative way, the transient performance of the estimator.

In the second part of the talk we discuss some new techniques to deal with the highly complicated -but, alas, often encountered in applications- non-separable NLP. We concentrate our attention on the case of NLP of the form $e^{\theta_i(t)} h_i(t)$, which is very common in physical systems. In the third part of the talk, we show that for nonlinear dissipative systems it is possible to derive an alternative parameterization, which is much simpler than the one usually derived directly from the system dynamic equations. Finally, we present some challenges in adaptive systems theory and survey some new theoretical results aimed at solving them.

3. GENERALIZED PARAMETER ESTIMATION-BASED OBSERVERS (GPEBO): COMPARISON WITH OTHER METHODS AND A UNIFYING FRAMEWORK.

Viernes, 26 de abril
16:00 a 17:30 hrs.

In the first part of the talk we present a new approach to state observation whose main idea is to translate the state estimation problem into one of estimation of constant, unknown parameters.

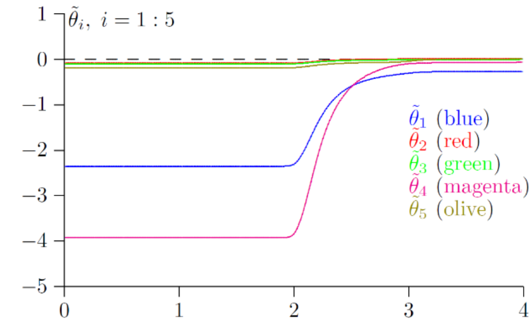
The class of systems for which GPEBO is applicable is identified via two assumptions related to the transformability of the system into a suitable

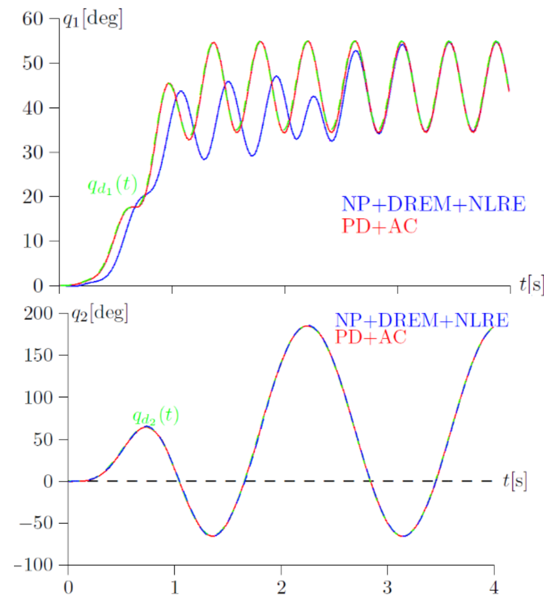
$$M(q) = \begin{bmatrix} \theta_1 + 2\theta_2\cos(q_2) & \theta_3 + \theta_2\cos(q_2) \\ \theta_3 + \theta_2\cos(q_2) & \theta_3 \end{bmatrix},$$

$$C(q,\dot{q}) = \begin{bmatrix} -\theta_2\sin(q_2)\dot{q}_2 & -\theta_2\sin(q_2)(\dot{q}_1+\dot{q}_2) \\ \theta_2\sin(q_2)\dot{q}_1 & 0 \end{bmatrix},$$

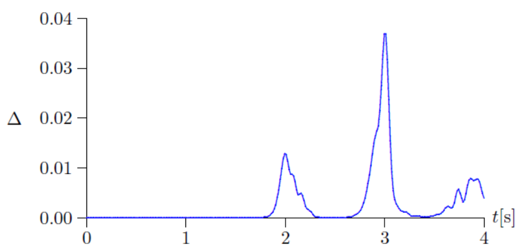
$$g(q) = \begin{bmatrix} \theta_4 g\sin(q_1) + \theta_5 g\sin(q_1+q_2) \\ \theta_5 g\sin(q_1+q_2) \end{bmatrix}.$$

cascaded form and our ability to estimate the unknown parameters. The first condition involves the solvability of a partial differential equation while the second one requires some excitation conditions. The estimation of the parameters is carried out using the powerful Dynamic Regressor Extension and Mixing (DREM) technique that translates the identification of a q-dimensional vector into q scalar estimation problems, whose convergence is guaranteed with the weakest possible excitation condition.

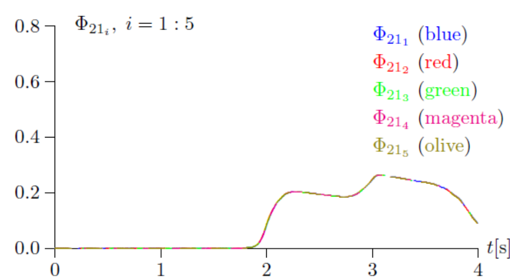




GPEBO is shown to be applicable to position estimation of a class of electromechanical systems, for the reconstruction of the state of power converters and for observation of the state of power systems equipped with PMUs. Moreover, its successful application to linear time-varying systems is guaranteed imposing only the necessary condition of observability. Extensions to the case of unknown parameters, delayed measurements and rejection of external perturbations are also discussed.



In the second part of the talk we present PEBO in a unified framework together with the— by-now classical—Kasantzis-Kravaris-Luenberger and Immersion and Invariance observers. The performance of the PEBO is compared with the one of a high gain observer in a power converter.



As expected, it is shown that the performance of the latter design is significantly below par with respect to the PEBO technique.