Current, position, and shape control in tokamaks

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The need of achieving always better performance in present and future tokamak devices has pushed plasma control to gain more and more importance in tokamak engineering (see [1]).
High performance in tokamaks is achieved by plasmas with elongated poloidal cross section. Since such elongated plasmas are vertically unstable, position control is clearly an essential feature of all machines. Beyond this, a strong motivation to improve plasma control is that, in order to obtain the best performance out of a device, it is always necessary to maximize the plasma volume within the available space; hence, the ability to control the shape of the plasma while ensuring good clearance between the plasma and the facing components is an essential feature of any plasma position and shape control system.
When high performance and robustness are required, it is essential to adopt a model-based approach to design a control system [1]. Hence, this lecture first introduces a plasma linearized model, which can be efficiently used to design plasma current, shape and position control systems. Afterwards the plasma shape control and the vertical stabilization problems are presented.
Design and implementation issues of two plasma magnetic control systems recently developed at the JET tokamak are discussed, namely the eXtreme Shape Controller [2],[3] and the new JET Vertical Stabilization System [4]. Eventually a plasma position and shape control approach proposed for the ITER tokamak is presented ([5],[6]).

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