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Forced Solutions of Streamwise Constant Plane Couette Flow
DENNICE GAYME, BEVERLEY MCKEON, California Institute of Technology, BASSAM BAMIEH, University of California, Santa Barbara, JOHN DOYLE, California Institute of Technology, ANTONIS PAPACHRISTODOULOU, University of Oxford — A two-dimensional, three-velocity component ($2D/3C$) model simulated under small-amplitude Gaussian forcing has been shown to capture salient features of turbulent plane Couette flow (Gayme et. al 2010). Periodic spanwise/wall-normal plane stream functions are used as input to develop forced $2D/3C$ streamwise velocities. The resulting steady-state solutions are qualitatively similar to a fully turbulent spatial field of DNS. Our analysis indicates that the momentum transfer which produces a 'turbulent-like' mean profile requires a nonlinear streamwise velocity equation. A system theoretic approach is used to study amplification mechanisms which arise through this $2D/3C$ nonlinear coupling. The forcing required to produce each input is used to define an induced norm. The associated input-output response determines the energy optimal spanwise wavelength over a range of Reynolds numbers. We identify an important tradeoff between the linear amplification mechanism and the nonlinearity required to develop an appropriately shaped turbulent velocity profile. **Acknowledgements:** The research is supported by Boeing and AFOSR. B.J.M. gratefully acknowledges NSF-CAREER award no. 0747672 (program managers W. W. Schultz & H. H. Winter).

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