CZ.1.05/1.1.00/02.0060: Stochastic resonance of a cylinder induced wind flow

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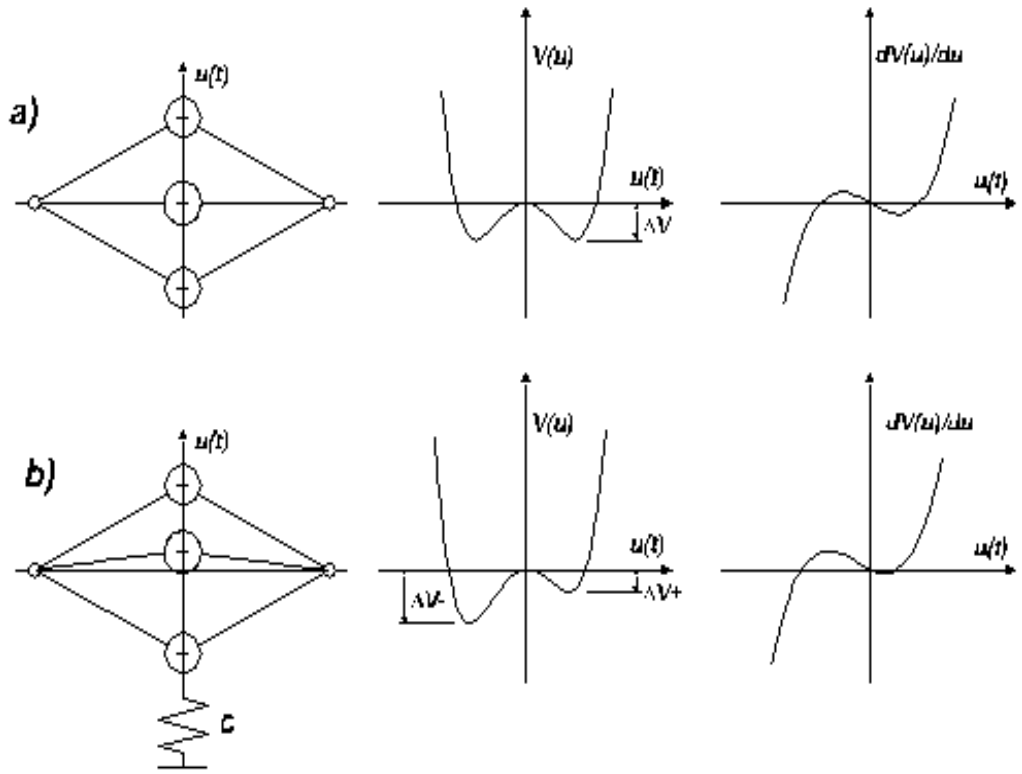
Motion instability can be a major cause for flexible structures, such as long-span bridges, in strong winds. Since turbulence is always present in a natural wind flow, the effects of turbulence on structural motion stability have become an important topic in wind engineering. If one accepts the notion that wind turbulence can be modelled as a stochastic process, then the subject belongs to that of stochastic stability. Mathematically speaking, stability must be defined in terms of boundedness and convergence. Since there are more than one way to define the convergence of a sequence of stochastic variables, several definitions of stochastic stability are possible.

Stochastic resonance – the phenomenon of periodic signals amplification under the influence of white noise of certain intensity. It is a universal phenomenon common to many nonlinear system under external influence both chaotic and weak periodic exposure.

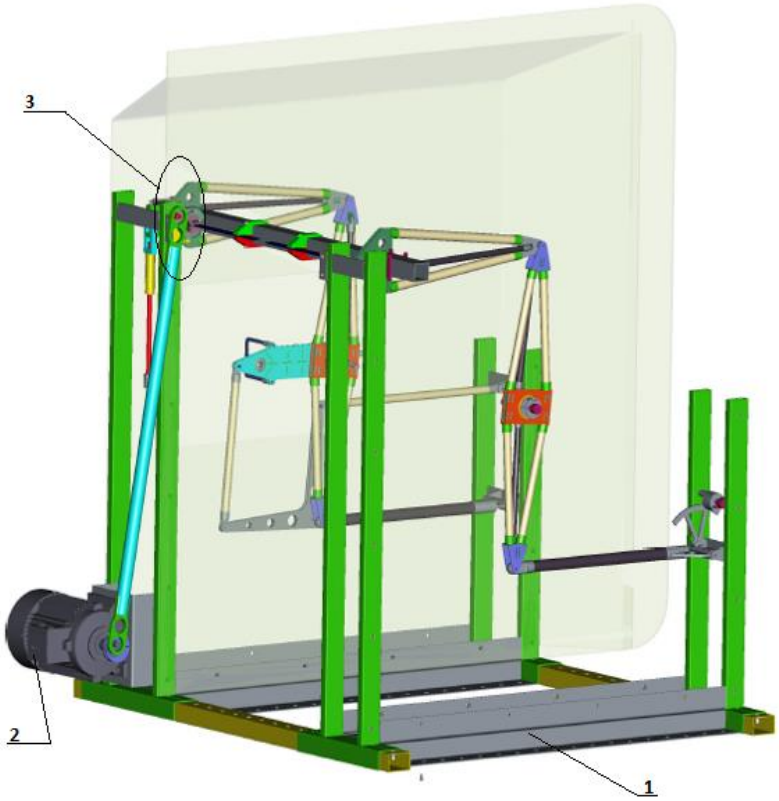
The response of a dynamic nonlinear single degree of freedom system to combination of additive random Gaussian white noise and external deterministic periodic force applied to the aerodynamic phenomena is studied. It is coming to light that under certain circumstances the jumping between wells of the bistable elastic potential can occur leading to internal hopping. The frequency of this hopping can be for certain combination of input parameters nearly constant and corresponding to external periodic force frequency. This state leads to high ratio of periodic component amplitude and intensity of the random component of the response process as the object was chosen cylinder in turbulent flow.

Main aim: to obtain experimental proof of stochastic resonance phenomenon for cylinder in turbulent flow.

The schematic diagram presented in the figure in two versions: (a) system with symmetric potential typical by an equivalent energy needed for hopping from the left into the right potential well and in opposite direction (b) system with asymmetric potential due to the supplementary linear string which could be able (when rising its stiffness) to bring the oscillator to monostable type as the object was chosen cylinder in turbulent flow. The weak periodic signal is a drag force produced by vortex shedding. Fluctuations in turbulent flow act as noise. Experimental setup consists of stand for bridge decks tests with electric motor and crank mechanism. Crank mechanism converts rotary motion to linear with harmonic nature.



Schematic diagram



Mechanism of stochastic resonance