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Preface to fourth Special Issue on Practical Asymptotics

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The aim of this Special Issue on Practical Asymptotics, the fourth such issue published in the *Journal of Engineering Mathematics*, is to collect a number of outstanding examples of studies in which formal asymptotics is used to provide invaluable information about mathematical models resulting from important practical problems. The following papers certainly meet that goal, and together illustrate how powerful these approaches can be, even today in the computer age.

This issue has a strong fluid-mechanics flavour, with studies on thin-film flows arising in the process of blade coating [1], dewetting from a hydrophobic substrate [2], and also viscous films that form inside the rim of a horizontal rotating cylinder [3]. Other topics in the fluid-mechanics discipline included here are high-Reynolds-number branching and network flows [4], time-dependent flows through curved pipes [5], low-Reynolds-number flow between two parallel rotating disks [6] and past a rotating cylinder [7], the classical dam-breaking problem [8], and premixed-flame propagation [9]. A few illustrative applications of these works are to blood flow in human arteries, coating processes in industry, or viscous pumps operating on the microscale. In addition, there is a paper that falls within the discipline of solid mechanics, studying edge wrinkling of thin elastic plates [10]. Finally, the issue contains two papers of a theoretical nature, one considering uniformly valid polynomial solutions to boundary-value problems [11], and the other concerned with 'beyond-all-orders' approaches to studying the asymptotic behaviour of spectral coefficients [12].

The analysis contained in this issue comprises a variety of perturbation methods, including repeated use of matched asymptotic expansions (with the usual suspects of inner and outer problems, corner regions, interior layers, etc.), boundary-layer theory, quite sophisticated multi-scale approaches, WKB analysis, exponential asymptotics, and more. In the usual manner, these techniques are made possible by careful consideration of the various mathematical models, and subsequent exploitation of small (or large) length- and/or time-scales, or small (or large) nondimensional parameters. Examples of such parameters in the present issue measure surface tension, rotation rates between plates, activation to thermal energies, fluid fluxes, weak and strong gravity effects, and aspect ratios or curvatures in problem geometry. Typically the asymptotic limits considered in these papers are singular in nature, with the most obvious examples arising when small parameters multiply higher-order derivatives in the governing equations, or when solutions themselves develop singularities in finite time. A browse through the following pages demonstrates how asymptotic methods link closely with topics such as linear stability theory, and often lead to,

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or can be exploited by, group-invariant methods involving self-similar solutions or travelling-wave solutions, thus combining a variety of the favourite analytical tools of an applied mathematician.

It is worth mentioning that most of the asymptotic treatments provided in the following papers are accompanied by numerical solutions to the appropriate governing equations. This occurrence is typical in studies in applied and engineering mathematics, and illustrates how each approach can complement the other. The important point is that there will always be problems for which perturbation methods may provide certain quantitative and/or qualitative information that computer simulations can not. It is thus still an exciting field to be researching in, and a valuable topic to teach in our undergraduate classrooms.

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