

# International Journal of Fluid Power

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## AIMS AND SCOPE

The *International Journal of Fluid Power* is dedicated to the latest advances in the science and technologies associated with hydraulics and pneumatics. The aim of the journal is to provide the engineering community with high quality information concerning developments in research, design and application of fluid power technology. Special emphasis is placed on papers concerned with components and system integration by embracing key aspects of:

- analysis, modelling and control,
- monitoring and fault diagnosis,
- artificial intelligence applications,
- component and systems design,
- computer software and hardware interfacing and
- computer aided engineering for both static and dynamic analysis of fluid power systems.

In addition, the journal commissions and publishes state-of-the-art reviews on both existing and emerging technologies, and with a philosophy of maintaining scientific rigour and the practical realities of fluid power. The International Editorial Board is composed of leading members of the fluid power community having expertise covering the broad spectrum of fluid power, and all papers are peer reviewed by at least two experts. Technical quality and integrity are considered crucial to the review process. The Associate Editors and the Editorial Board also undertake an active role in ensuring that this is achieved.

Currently, three issues are planned for 2002, but the journal is moving towards quarterly publication.

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# DEVELOPMENT OF ACCURATE AND PRACTICAL SIMULATION TECHNIQUE BASED ON THE MODAL APPROXIMATIONS FOR FLUID TRANSIENTS IN COM- POUND FLUID-LINE SYSTEMS

(1st Report : Establishment of fundamental calculation algorithm  
and basic considerations for verification of its availability)

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## Abstract

New simulation technique called the “system modal approximation” method for fluid transients in compound fluid-line systems is developed and presented. Unlike existing approaches based on the modal approximation of the input/output causality relationship of individual line element, this new method is based on the modal approximation of the frequency transfer function itself of the output (wanted variable) to the input (source) considering the dynamic characteristics of total system. This simulation technique also has the feature that only the numerical data of the frequency response of transfer matrix parameters of individual line element, which may be obtained from either theoretical model or experimental measurements, is needed and that the wanted output variable alone can be calculated selectively in the time domain by a simple algebraic expression in the form of recurrence formula. For complex fluid-line systems, the advantages of this technique over other existing modal approximation-based methods in accuracy, applicability, flexibility, computation time, etc. are discussed with experimental comparisons.

**Keywords:** fluid transients, water hammer, modal approximation, compound fluid-line system

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# A FINITE VOLUME CENTRAL DIFFERENCING SCHEME FOR SIMULATION OF THE SHUT DOWN PROCEDURE OF A HYDRAULIC SYSTEM

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## Abstract

A new central differencing finite volume scheme is investigated for solution of unsteady hydraulic problems as water hammer in pipe systems. Special time stepping procedure similar to Runge-Kutta algorithm is used to stabilize this second order scheme. It is monotonized by adding dissipative terms including second and fourth derivatives of the conserved variables, with coefficients proportional to derivatives of pressure or volumetric flow, which keeps the second order of accuracy in smooth flow regions. The one-dimensional unsteady incompressible equations are solved for a water hammer situation, and results are compared to existing analytical solutions. Results are also compared with numerical results of classical characteristic method, which is proved to be fairly accurate. The scheme could easily be generalized to two-dimensional case. Finally this procedure is used for analysis of the shut down procedure of a hydraulic system. Components of the system are modeled and effect of important parameters on the performance is studied.

**Keywords:** water hammer, hydraulic system analysis, finite volume schemes, shut down procedure

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# REALIZATION OF PROGRAMMABLE CONTROL USING A SET OF INDIVIDUALLY CONTROLLED ELECTROHYDRAULIC VALVES

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## Abstract

This paper reports a study of electrohydraulic valve function programmability and characteristic interchangeability using a set of individually controlled cartridge type electrohydraulic (E/H) control valves. Such an integrated individually controllable E/H valve is defined as the programmable E/H control valve. A hybrid control algorithm was developed to realize different valve functions via programmable logic and to realize different interchangeable valve characteristics via a programmable valve modulation function. Evaluation test results verified that the programmable E/H control valve was capable of replacing different types of conventional proportional control valves and, more importantly, capable of realizing the flow regeneration function. The programmability of the programmable E/H control valve provides the flexibility of using the same firmware of an E/H control valve on various applications by simply downloading different control software.

**Keywords:** programmable E/H control valve, valve function programmability, valve characteristics interchangeability, flexible control software

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# DESIGN OF CASCADE CONTROLLERS FOR A HYDRAULIC ACTUATOR

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## Abstract

This paper addresses the design of the cascade controllers for the position trajectory tracking control in hydraulic actuators. The cascade strategy consists in interpreting the hydraulic actuator mathematical model as two interconnected subsystems: a mechanical subsystem driven by a hydraulic one. From this interpretation, cascade controllers with suitable properties were proposed. In this paper, in order to state the design guidelines for the cascade controllers gains, a theoretical analysis focusing on the relations between controllers gains and performance is presented. Implementation aspects required to obtain an optimised performance are also discussed. Experimental results support the design guidelines and the implementation aspects approached in this work.

**Keywords:** hydraulic actuators, cascade strategy, design guidelines, controller tuning, valve dynamics

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# ESTABLISHING OPERATING POINTS FOR A LINEARIZED MODEL OF A LOAD SENSING SYSTEM

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## **Abstract**

A load sensing system is one in which the pump flow is adjusted to keep pressure across an orifice constant and independent of any variation in the load pressure. This ensures that the pressure losses across the orifice are kept to a minimum which increases efficiency substantially. Because the system is closed loop, stability can become a problem. To establish stability bounds, linearized analysis is often employed. However, to do this, operating points of all linearized parameters and coefficients must be established as a function of certain parameters such as load pressure. This can only be done by solving a series of nonlinear algebraic equations. This paper presents a set of equations for three special conditions. The experimental verification of operating points that are predicted for such a load sensing system is presented. The three regions are established theoretically and are verified experimentally. It is found that the operating points undergo a noticeable change when in transition from one region to another (as dictated by variations in load pressure or orifice area). It was also found that the agreement between the predicted and measured operating points was quite satisfactory and could be used with confidence in future studies.

**Keywords:** load sensing, steady state operating point, transition point, pressure regulator, pressure control pump

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