Computer Code Abstracts

TRIFIDO

1. Name of Code: TRIFIDO, a code for calculating kinetic parameters of subcritical neutron multiplying assemblies using pulsed-neutron experimental data.
2. Computer for Which Code is Designed: IBM/360-65 or BULL-625. Programming Language Used: FORTRAN IV.
3. Nature of Physical Problem Solved: The code calculates decay constant and the population of the fundamental prompt-neutron mode extrapolated to initial time, using pulsed neutron experimental data. These data are the resulting time profile of the neutron density of a subcritical multiplicative assembly which is repetitively pulsed with short bursts of neutrons. The time profile is measured by an appropriate detector and recorded with a time analyzer. With the calculated parameters the code determines the values of $k\beta/L$ and the reactivity by means of the Garelis-Russell[1] method, and the reactivities using the Gozani[2] and Sjöstrand[3] methods.
4. Method of Solution: Least-squares weighted fit for the decay constant and the extrapolated-population calculations; iteration for the Garelis-Russell method.
5. Restrictions on the Complexity of the Problem: The code is presently restricted to 256 experimental data points (for example, those provided by a TMC multichannel analyzer). This number is adequate for most pulsed neutron measurements. The restriction can be easily overcome, if necessary, by changing a dimension card. Minor parameter adjustments are needed according to the multiplying systems used and to the experimental procedure.
6. Typical Machine Time: 3.60 sec for 1 case in a BULL GE-625 computer, 16.92 sec for 10 cases; 70% of these times on an IBM/360-65 computer.
7. Unusual Features of the Program: It calculates several pairs of decay constants and extrapolated populations of the fundamental prompt-neutron mode varying the starting analysis channel (initial time). Since the code selects as fundamental prompt mode values those which provide the best agreement between fitted and experimental values, it can proceed directly to calculation of $k\beta/L$ and reactivity. Thus, all these kinetic parameters are obtained in only one computer run. To provide visual checking, the code draws a graph of the experimental data, corrected for noise and dead-time effects, and the fitted values.
8. Status: In use.
9. Machine Requirements: 10K words core on BULL GE-625, 11K words core on IBM/360-65.
10. Operating System or Monitor Under Which Program is Executed: Gecos 3 on BULL GE-625, OS/360 or IBM/360.
11. Material Available (from Departamento de Reactores, Comisión Nacional de Energia Atómica, Argentina, and Argonne Computer Code Center): FORTRAN deck, test problem, test problem results, instruction manual.
12. *References*:

[1]E. GARELIS and J. L. RUSSELL, *Nucl. Sci. Eng.*, **16**, 263 (1963).
[2]T. GOZANI, EIR-Bericht Nr. 79 (April 1965).
[3]N. G. SJÖSTRAND, *Ark. Fys.*, **11**, 233 (1957).

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Received November 2, 1970
Revised June 22, 1971

ANCON

A Point-Kinetics Program with Nonlinear Feedback

1. Name of Code: ANCON[1]
2. Computer for Which Code is Designed: CDC-6600. Because ANCON is written entirely in FORTRAN and does not require any special system routines or equipment, it should be operable on most computers.
3. Nature of Physical Problem Solved: ANCON solves the point-reactor kinetic equations including thermal feedback. Lump-type heat balance equations are used to represent the thermodynamics, and the heat capacity of each lump can vary with temperature. Thermal feedback can be either a linear or a nonlinear function of lump temperature, and the impressed reactivity can be either a generalized polynominal function or a sinusoidal function.
4. Method of Solution: The system of coupled first-order differential equations is solved by a method based on continuous analytic continuation.[2,3] The basic procedure consists of expanding all the dependent variables except reactivity in Taylor series, with a truncation error criterion, over successive intervals on the time axis. Variations of the basic procedure are used to increase the efficiency of the method in

special situations. Automatic switching from the basic procedure to one of its variations (and vice versa) may occur during the course of a transient. The method yields an analytic criterion for the magnitude of the time step at any point in the transient.

5. Restrictions on the Complexity of the Problem: The code is currently restricted to a maximum of six delayed neutron groups and 56 lumps. Larger problems can be accommodated on a 65K computer by increasing the dimensions of a few subscripted variables. Because there are no provisions for describing transport delays, only the open-loop response of a reactor can be computed with ANCON. Also, the code is currently restricted to a constant external neutron source.

6. Typical Running Time: Running time is highly problem dependent, depending on such factors as the number of equations in the system, the feedback and heat balance options used, the time at which the transient is terminated, and whether the transient is slow or fast. Most problems run with ANCON required 1 to 10 min on the CDC-6600.

7. Unusual Features of the Program: The most important characteristic of the computational method is that it yields an analytic criterion for the magnitude of the time step. This criterion is such that the time step automatically expands or contracts, depending on the behavior of the dependent variables within each interval. The use of this criterion guarantees that the accumulated fractional error in each dependent variable is always less than or equal to $n\epsilon$, where n is the number of time steps and ϵ is an input truncation error parameter. Also, the code is structured in a form such that reactivity, heat balance, and source options other than those presently available can be incorporated with a minimum of code modification.

8. Related and Auxiliary Programs: The ANCON output is printed but not plotted because plotting programs are frequently system dependent. However, the output is saved on logical unit TAPE1, which may be either a tape unit or a disk file. From TAPE1, the user can make plots with his own plotting program.

9. Status: In use.

10. Machine Requirements: ANCON requires $32\,000_{10}$ words of central memory, one peripheral storage device, and the usual I/O devices (card reader, printer, and card punch). Standard system library functions and a CLOCK routine are used. The CLOCK routine is not essential.

11. Programming Language Used: FORTRAN IV.

12. Operating System: CDC-SCOPE 3.2.

13. Material Available: A source deck, source listing, sample problem, sample problem results, and program report[1] are available from the author. A complete code package has been submitted to the Argonne Code Center.

14. *Acknowledgment*: This work was performed under the auspices of the United States Atomic Energy Commission.

15. *References*:

[1]J. C. VIGIL, "ANCON User's Manual," LA-4616, Los Alamos Scientific Laboratory (1971).

[2]J. C. VIGIL, "Solution of the Nonlinear Reactor Kinetics Equations by Continuous Analytic Continuation," LA-3518, Los Alamos Scientific Laboratory (1966).

[3]J. C. VIGIL, "Solution of the Reactor Kinetics Equations by Analytic Continuation," *Nucl. Sci. Eng.*, **29**, 392 (1967).

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Received May 17, 1971