## Memoirs on Differential Equations and Mathematical Physics VOLUME 57, 2012, 1–15



## Eightieth Birthday Anniversary of Kusano Takaŝi

On December 30, 2012 Kusano Takaŝi, member of the Editorial Board of our journal, Professor Emeritus at Hiroshima University, Doctor of Science, became 80 years of age.

T. Kusano was born in a small town Shimabara, Nagasaki Prefecture, in Kyushu which is one of the four main islands forming the archipelago of Japan. In 1936 his family moved to Manchuria which was then a puppet nation made up by the Japanese Government in 1932 as his father took a job (assistant professor of mathematics) with Changchun Technical University.

His family lived in Changchun for ten years until they were repatriated to Japan in 1946 after World War II apart from his father who in the end of 1945 was arrested (by mistake) by the Soviet Army as a war criminal and was taken to Kazakhstan in USSR for forced labor.

In 1951 he left the Shimabara high school with honors and in 1955 he graduated from the Faculty of Science of the University of Tokyo, majoring in pure mathematics. Then he was admitted to its Graduate School by recommendation and began to study differential equations under the supervision of Professor Masuo Hukuhara. He remembers quite well that at the first meeting with his supervisor Professor Hukuhara said to him "We are now at the dawn of the era of nonlinear differential equations. Don't forget that fixed point theorems are one of the most important and useful tools in the analysis of nonlinear problems". His research subject was the qualitative theory of second order nonlinear partial differential equations of elliptic and parabolic types. After having obtained the Master's degree in 1957 he went to the Doctor's course, but in 1958 he had to leave the course halfway as he was offered the job of lecturer at Ibaraki University. It was in 1965 when he defended his doctoral dissertation submitted to the University of Tokyo.

After having taught at Ibaraki University (1958–1960), Nagasaki University (1960–1962), Chuo University (1962–1967) and Waseda University (1967–1969), he was appointed to be Full Professor of Hiroshima University in 1969 and served in Department of Mathematics, Faculty of Science, for twenty five years since then. In 1970 he changed his research subject from partial differential equations to ordinary differential equations under the influence of the oscillation theory created by Professor Ivan Kiguradze, and organized the seminar on oscillation of nonlinear ordinary differential equations with or without functional arguments. The seminar encouraged a number of graduate students to be active specialists in oscillation theory of differential equations, ordinary or partial. In 1994 he transferred to Fukuoka University to work for Department of Applied Mathematics, Faculty of Science for the last nine years of his career as a university professor. Since 2000, motivated by the work of Professor Vojislav Marić, he has been enthusiastic about the asymptotic analysis of positive solutions of differential equations by means of Karamata functions (or regular variation).

His scientific activities during his academic life include invited speeches at many international conferences on differential equations held in Europe and the Unites States, services as a member of the editorial board of the journals: Memoirs of Differential Equations and Mathematical Physics, Funkcialaj Ekvacioj, Hiroshima Mathematical Journal, Applied Mathematics E-Notes, and Studies of the University of Žilina (Mathematical Series), and supervision of nineteen students who successfully defended their Ph. D theses. Besides he is a permanent visiting professor of Northeast Normal University.

The main areas of T. Kusano's scientific investigations are broadly classified into the following four categories.

### (I) Qualitative study of second order elliptic and parabolic partial differential equations:

(i) The construction of entire solutions (solutions defined in the entire space  $\mathbf{R}^N$ ) and the solvability of exterior boundary value problems for a class of second order quasilinear elliptic equations. See e.g. [5], [6], [8].

(ii) The study of time change of solutions as functions of the space variable of the Cauchy problem for a class of second order linear parabolic equations and systems with unbounded coefficients. See e.g. [14], [17], [21].

### (II) Oscillation theory of differential equations:

Since 1970 he has studied oscillation properties of differential equations in hopes of proceeding in the mainstream of oscillation theory created by F. V. Atkinson and I. T. Kiguradze. The equations considered by him include both ordinary and partial differential equations with or without functional arguments which can be regarded as generalizations of the Emden– Fowler equation. Various kinds of equations have been the objects of his investigations in this direction as listed below.

- (i) Ordinary differential equations of generalized Emden–Fowler type in which the principal parts involve higher order linear differential operators such as  $(p(t)x^{(n-m)})^{(m)}$  and  $(p_{n-1}(t)(\cdots(p_1(t)(p_0(t)x)')'\cdots)')'$ . See e.g. [39], [61], [68].
- (ii) Ordinary differential equations of generalized Emden–Fowler type in which the principal parts involve second order nonlinear differential operators such as  $(p(t)|x'|^{\alpha-1}x')'$ .
  - (a) Half-linear equations [160], [165], [171].
  - (b) Non-half-linear equations [140], [151], [164].
- (iii) Nonoscillatory ordinary differential equations which can be turned into oscillating systems as a result of introduction of functional arguments. See e.g. [72], [85], [159].
- (iv) Ordinary differential equations of neutral type.
  - (a) First order equations having difference operators of degree 1 [132], [137], [142];
  - (b) Higher order equations having difference operators of degree 1 [129], [131], [143];
  - (c) Higher order equations having difference operators of higher degree [148], [163], [166].
- (v) Partial differential equations.
  - (a) Nonlinear harmonic and metaharmonic equations [56], [63], [120];
  - (b) Non-elliptic equations [87], [100], [212].

# (III) Existence and asymptotic behavior of positive solutions of nonlinear differential equations:

The following is a record of what he has done in his attempts at acquiring detailed and precise information about the asymptotic behavior of positive solutions of differential equations in mathematical physics.

- (i) Positive solutions of ordinary differential equations of generalized Emden–Fowler type. See e.g. [83], [99], [104], [124], [125].
- (ii) Positive solutions of second order semilinear elliptic equations in exterior domains. See e.g. [81], [98], [102].
- (iii) Positive entire solutions of second order semilinear and quasilinear elliptic equations. See e.g. [107], [111], [157].
- (iv) Positive entire solutions of higher order semilinear and quasilinear elliptic equations. See e.g. [117], [156], [172].
- (v) Positive entire solutions of Monge-Ampère equations. See e.g. [135], [139], [141].

## (IV) Asymptotic analysis of positive solutions in the framework of regular variation:

Inspired by the book of V. Marić entitled "Regular Variation and Differential Equations" published in 2000, he started studying theory of regular variation in the sense of Karamata and came before long to find a number of problems on differential equations that could be solved by means of regularly varying functions. What he has done in this regard is as follows.

- (i) The construction of regularly varying solutions for various types of linear and nonlinear ordinary differential equations with or without functional arguments. See e.g. [218], [229], [235].
- (ii) The introduction of the concept of generalized regularly varying functions and its application to the analysis of asymptotic behavior of positive solutions of more complicated differential equations than those considered in (i). See e.g. [223], [225].
- (iii) The detection of the fact that if one's attention is restricted to generalized Emden–Fowler equations with regularly varying coefficients, then thorough and complete information can be obtained about the existence and asymptotic behavior of all possible regularly varying solutions of the equations under consideration. See e.g. [237]–[239].

We cordially wish Professor Kusano Takaŝi good health, long life and new successes in his scientific activities.

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