Annexure – IX

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE FINAL REPORT OF THE WORK DONE ON THE PROJECT

Title of the Project : **Inverse Problem for Hyperbolic Partial Differential Equations**

1. Name and Address of the Principal Investigator : Dr. P. Prakash
   Associate Professor
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2. Name and Address of the Institution : Periyar University
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   Tamil Nadu, India

3. UGC Approval Letter No. and Date : F. No. 41-798/2012(SR) dated 18 July 2012

4. Date of Implementation : 01.07.2012

5. Tenure of the Project : Three years and six months from 01.07.2012 to 31.12.2015

6. Total Grant Approved : Rs. 8,73,542

7. Total Grant Received : Rs. 8,11,368

8. Final Expenditure : Rs. 7,50,542

9. Unspent Balance : Rs. 60,826

10. **Title of the Project** : **Inverse Problem for Hyperbolic Partial Differential Equations**

11. Objectives of the Project:

The objectives of the research plan are to determination of unknown parameters in a hyperbolic differential equation by optimal control methods.

- Inverse problem of reconstructing of spacewise dependent source term in a wave equation from boundary measurement.
- Inverse problem for a quasilinear wave equation with an unknown coefficient via boundary observation.
- Inverse problem of determining a coefficient in a hyperbolic equation with impulsive inputs.
- Inverse problem for fractional wave equation from additional data.

We will explores numerical approximation of inverse problems for hyperbolic differential equation and the numerical results to be established by using mathematical tools such as Mathematica and Matlab.

12. Whether Objectives Were Achieved
(Give Details) : **Yes**

We have investigated the inverse problem for identifying a space dependent source term of wave equation using optimal control framework.

A similar method has been applied for the inverse source problem for the time-fractional diffusion equation.

We have applied generalized and revised generalized Tikhonov regularization method for the inverse source problem for time-fractional diffusion equation.

Further, we have adopted the backward problem for a time-fractional diffusion equation by using the revised generalized Tikhonov regularization method.

13. Achievements from the Project :

Publications :

- A. Deiveegan, P. Prakash and J. J. Nieto, Optimization method for identifying the source term in an inverse wave equation, **Electronic Journal of Differential Equations, 2017 (2017) 1--15.**

- A. Deiveegan, Two-parameter regularization method for determining the heat source, **Global Journal of Pure and Applied Mathematics, 13(2017) 3937--3950.**
- Yong Ki Ma, P. Prakash and A. Deiveegan, Generalized Tikhonov methods for an inverse source problem of the time-fractional diffusion equation, **Chaos, Solitons & Fractals (ScineceDirect), 108 (2018) 39--48.**
- Yong Ki Ma, P. Prakash and A. Deiveegan, Optimization method for determining the source term in fractional diffusion equation, **Mathematics and Computers in Simulation (ScineceDirect), (DOI** https://doi.org/10.1016/j.matcom.2018.03.003).
- A. Deiveegan, J. J. Nieto and P. Prakash, The revised generalized Tikhonov method for the backward time-fractional diffusion equation, **Journal of Applied Analysis and Computation (To appear).**

14. Summary of the Findings
(In 500 Words) : **See Enclosure – I**

15. Contribution to the Society :

The study of inverse problems tries to propagate useful information about indirect or deficient observations, or observations that contain measuring errors, with the help of mathematical models. This is one of the most topical and significant research subjects in applied mathematics. In this regard the project is an important contribution to the development of the field.

16. Whether any Ph.D. Enrolled/Produced out of the Project : **Yes**

Project Fellow has awarded Ph.D.

17. No. of Publications out of the Project
(Please Attach) : **4 Publications (Attached), 1 In Press**

5/4/2018
(PRINCIPAL INVESTIGATOR)

Dr.P. PRAKASH
Associate Professor
Department of Mathematics
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23.4.18
(REGISTRAR)

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Enclosure – I

Summary of the findings of the study

We have investigated the inverse problem of identifying a spacewise dependent source term of wave equation. On the basis of the optimal control framework, the inverse problem had been transformed into an optimization problem. The existence and necessary conditions of the minimizer for the cost functional were obtained. The projected gradient method and two-parameter model function method have been applied to the minimization problem.

A similar method has been applied for the inverse source problem for the time-fractional diffusion equation. The Landweber iteration algorithm has been applied to the inverse problem.

We have discussed the inverse problem of determining a heat source in one-dimensional heat equation. The regularization solution of the inverse problem has been given by a two-parameter regularization. Also we have proposed a model function approach to the Morozov principle for choosing regularization parameter.

We have applied generalized and revised generalized Tikhonov regularization method for the inverse source problem for time-fractional diffusion equation. Convergence estimates under *a-priori* and *a-posteriori* regularization parameter choice rules were given.

We have adopted the backward problem for a time-fractional diffusion equation with variable coefficients in a bounded domain by using the revised generalized Tikhonov regularization method. Convergence estimates under *a-priori* and *a-posteriori* regularization parameter choice rules were given. The computation has been carried out using the software MATHEMATICA.