# PROGRAM PLAN AND SEMESTER LEARNING ACTIVITIES (RPKPS) SCHOOL YEAR 2021/2022

Geophysics Inversion Method

MFG-4607/ 2 credits

Supervisory Team:

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**UNIVERSITAS GADJAH MADA FACULTY OF MATHEMATICS AND NATURAL SCIENCES**
**2021**

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| | **Gadjah Mada University**<br>Faculty of Mathematics and Natural Sciences<br>Department of Physics / S1 Geophysics Study Program Academic Year 2021/2022 | | **Document Code:**<br>..... |

## SEMESTER LEARNING PROGRAM AND ACTIVITY PLAN (RPKPS)

| Course Code | Course Name | Weight (credit) | | Semester | Course Status | | Prerequisite Courses |
|---|---|---|---|---|---|---|---|
| *MFG-4607* | *Inversion Method* | *T: 2* | *P:-* | *Odd* | *Choice* | | *MFF-1012 (Basic Physics II)* |

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| **Course Brief Description** | This Inversion Method course (MFG-4607) introduces and instills the basics of applied inversion method science and the field of geophysics and examples of its applications. This course contains an introduction to inversion problems, linear inversion, inversion theory, examples of advanced modeling, review of linear algebra and statistics. | |
| **Graduate Learning Outcomes (CPL) Charged to MK** | ***CPL1*** | **Good Attitude:** Graduates are honest, disciplined, curious, critical, confident, independent, emotionally mature, cooperative, and trustworthy. Uphold norms, values, morals, religion, general ethics and professional ethics, and actively play a role in the global movement of sustainable development and behave professionally |
| | ***CPL2*** | **Mastery of general knowledge:** Graduates are able to apply basic science (mathematics, physics, chemistry, biology, geology), and geophysics in general and their relationship with other sciences such as geology, geodesy, geochemistry, geography, computing and information technology. |
| | ***CPL5*** | **Synthesis and Evaluation Skills** : Graduates are able to interpret geophysical data in the form of solving advanced and reverse problems (inverse problems) in an integrated manner that have ambiguous characters, carry out interpretation by making models and / or solving simple forward and reverse problems and are skilled in the use of computers both for the purposes of solving geophysical problems and for communication and internet access |
| | ***CPL6*** | **Managerial skills and self-development**: Graduates are able to update their competencies, namely by life-long learning in line with the latest geophysical conditions to compete nationally and internationally by upholding UGM values (Pancasila: Divinity, Humanity, Unity, Peoplehood, Justice, and Science: universality, objectivity, freedom, respect for reality and truth) |
| **Course Learning Outcomes (CPMK)** | **After completing the learning of this course, students are expected to be able to:** | |
| | ***CPMK-1*** | Introducing the inversion method. [CPL-2] |
| | ***CPMK-2*** | Instilling the basics of the science of inversion methods. [CPL-1, CPL-2] |
| | ***CPMK-3*** | Applications of inversion methods in geophysics [CPL-2, CPL-5, CPL-6] |

**CPL mapping with CPMK**

| | CPMK1 | CPMK2 | CPMK3 |
|---|---|---|---|
| CPL-1 | | | |
| CPL-2 | | | |
| CPL-5 | | | |
| CPL-6 | | | |

| The Relationship of CPMK with Learning Materials and Forms. | | Learning Materials | Forms of Learning | Time Allocation |
|---|---|---|---|---|
| | ***CPMK-1*** | Inversion problems in geophysics | TCL, SCL, and discussion | 2 Hour |

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|---|---|---|---|---|
| **As well as Time Allocation** | ***CPMK-1*** | Models, discretization of continuous models, advanced and inverse modeling, linear regression, types of inversion problems, linear functions, formulation of inversion problems | TCL, SCL, and discussion | 2 Hours |
| | ***CPMK-2*** | *Least-square problems,* discrete linear inversion problems, over-determination problems, parameter estimation*, goodness of fit*, probabilistic distribution | TCL, SCL, and discussion | 2 Hours |
| | ***CPMK-2*** | Taylor expansion, linear versus nonlinear relations, linear algebra, matrix-vector multiplication, matrix-matrix multiplication*, outer product,* inner product*, range, nullspace*, rank, *norm , matrix inverse, matrix relations* | TCL, SCL, and discussion | 2 Hours |
| | ***CPMK-2*** | Matrix operations, functions and plots (2D and 3D) | TCL, SCL, and discussion | 2 Hour |
| | ***CPMK-3*** | *Over-determined,* discrete linear inverse problem: linear regression problem, example *Ballistics* | TCL, SCL, and discussion | 2 Hours |
| | ***CPMK-3*** | Earthquake epicenter, linearized inversion | TCL, SCL, and discussion | 2 Hour |
| | **UTS/Project Task Results/Case Analysis** | | | |
| | ***CPMK-1*** | Introduction: *curve fittings,* acoustic tomography, seismic tomography, convolutions | TCL, SCL, and discussion | 2 Hours |
| | ***CPMK-2*** | Inversion method based on data-error, misfit vector, and model parameter vector. | TCL, SCL, and discussion | 2 Hours |
| | ***CPMK-2*** | Linearization of nonlinear problems | TCL, SCL, and | 2 |
| | ***CPMK-2*** | The eigenvalue problem | TCL, SCL, and | 2 |
| | ***CPMK-3*** | Singular-value decomposition (SVD) | TCL, SCL, and discussion | 2 Hour |
| | ***CPMK-3*** | *Generalized inverse* | TCL, SCL, and | 2 |
| | ***CPMK-3*** | Stochastic inversion problem | TCL, SCL, and | 2 |
| | **UAS/ Project Task Results/ Case Analysis** | | | |
| **Learning Methods** | Student centered Learning, Presentations, discussions | | | |
| **Student Learning Experience** | Students listen to the lecturer's explanation when the lecturer presents, then continues the discussion / question and answer. | | | |
| **Access Learning Media / LMS and Offline &; Online Percentage** | LCD, paper, Simaster and ELok (e-learning), presentation impressions. | | | |

**Assessment Methods and Alignment with CPMK**

| Assessment Techniques | Assessment Percentage | Criteria/Indicators | CPMK1 | CPMK2 | CPMK3 |
|---|---|---|---|---|---|
| **Participatory Activities*)** | 15 | Participation Rubric | | | |

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|---|---|---|---|---|---|---|
| | **Project Results/ Case Study Results/ PBL Results*)** | | | | | |
| | **Cognitive** | | | | | |
| | **UTS** | 42,5 | Answer key | | | |
| | **UAS** | 42,5 | Answer key | | | |
| | **Total** | 100 | | | | |

*) can also be obtained from UTS or UAS which is the result of participatory activities or *project* / case study results. In accordance with IKU 7, **the percentage of** participatory activities and project results/case studies/PBL results is at least 50%.

**Reference List**


1. Albert Tarantola, 2005, Inverse Problem Theory and Methods for Model Parameter Estimation, Siam
2. Menke, 1989, Geophysical data analysis: discrete inverse theory, Academic Press.
3. Randall M. Richardson and George Zandt, 2007, Inverse Problems In Geophysics, 2007, Department of Geosciences, University of Arizona, Tucson, Arizona 85721
4. Richard C. Aster, Brian Borchers, 2012, Parameter Estimation and Inverse Problems, Elsevier.
5. Robert L. Parker, 1994, Geophysical Inverse Theory,


**Name of Lecturer (*Team Teaching*)**

1. Ari Setiawan
2. Theodosius Marwan Irnaka

| **Authorization** | **Drafting Date** | **Course Coordinator** | **Coordinator of Expertise (if any)** | **Head of Study Program** |
|---|---|---|---|---|
| | *Aug 18, 2022* | Dr.Ing. Ari Setiawan, M.Si. | Dr. rer.nat. Ade Anggraini, M.T. | Dr. Sudarmaji, MSi. |