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

Physical

Geophysics

Gravity and Magnetic Methods

MFG 3113/ 3 credits

Mentoring 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 3113* | *Gravity and Magnetic methods* | *T: 3* | *P: -* | *Complete* | *Mandatory* | *Mathematical physics III, Met. Geophysical Analysis I* |

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| **Course Brief Description** | Gravity Method<br>Properties of rocks that can be detected by gravity, gravitational potential field theory (e.g. Newton's law of gravity, scalar potential, Laplace's equation, Poisson's equation, equivalent layers, upward and downward potential field continuation, potential differentiation, multi-polar field expansion), use of potential field theory (e.g. calculating excess mass, determining the position of the center of mass), collection of gravity data (e.g. gravitymeter, calibration, tidal effects, work procedures in the field). Reduction of gravity data (e.g. latitude effect, elevation effect, Bouguer effect, topogra effect□, transfer of data from topogra surface□ to horizontal plane, creation of gravity anomaly contour map), gravity data processing (e.g. separation of regional and residual effects, derivation, continuity up and down, use of density log data), interpretation (e.g. the principle of ambiguity of interpretation results as a consequence of solving inversion problems, direct interpretation with downward continuity, direct interpretation with multi-pole expansion, indirect interpretation using characteristic curves, and modeling).<br>Magnetic Method<br>Earth's magnetic main field, corrections in geomagnetic data, reduction to horizontal plane, Magnetic anomaly, Stratum equivalent principle, Pseudo gravity, Magnetic field continuity, Demagnetization, Magnetic field reduction to poles, Separation of regional-residual anomalies, Characteristic curves, Numerical calculation of pro□l anomalies, depth estimation from aeromagnetic surveys, magnetic minerals, various kinds of magnetization of rocks.<br>Case examples in geo□sika.<br>After attending lectures and passing this course exam, students are expected to understand and master the basic principles of gravitational and magnetic exploration surveys, solve conceptual and practical questions about the source of the earth's gravitational and magnetic fields and their properties. |
| **Graduate Learning Outcomes (CPL) Charged** | ***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 |

<table>
<tr><td rowspan="4">to MK</td><td>CPL2</td><td>Mastery of 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.</td></tr>
<tr><td>CPL3</td><td>Operational and comprehensive skills: Graduates are able to apply all geophysical methods (seismic, gravitational, magnetic, electrical, electromagnetic, and thermic methods) for energy exploration (e.g. oil and gas, coal, geothermal), mining materials (eg: iron, copper, gold, silver, tin) as well as groundwater and disaster mitigation</td></tr>
<tr><td>CPL4</td><td>Application and analysis skills: Graduates are able to carry out and manage a geophysical survey which includes scientific steps in the acquisition, processing and interpretation of data for the exploration of natural resources both for energy (e.g. oil and gas, coal, for energy exploration (e.g. oil and gas, coal, geothermal), mining materials (eg: iron, copper, gold, silver, tin) as well as groundwater and disaster mitigation</td></tr>
<tr><td>CPL5</td><td>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</td></tr>
<tr><td rowspan="6">Course Learning Outcomes (CPMK)</td><td colspan="2">After completing the learning of this course, students are expected to be able to:</td></tr>
<tr><td>CPMK1</td><td>Introducing the Gravity and Magnetic Method [CPL-2]</td></tr>
<tr><td>CPMK2</td><td>Imparting knowledge for Gravity and Magnetic data measurement [CPL-1,CPL-2]</td></tr>
<tr><td>CPMK3</td><td>Processing Gravity and Magnetic data [CPL-2]</td></tr>
<tr><td>CPMK4</td><td>Gravity and Magnetic Anomaly Analysis [CPL-2, CPL-3,CPL-4]</td></tr>
<tr><td>CPMK5</td><td>Modeling the density and geometry of Gravitational and Magnetic anomalies [CPL-3, CPL-4, CPL-5]</td></tr>
<tr><td>CPL Mapping with CPMK</td><td colspan="2"><table>
<tr><th></th><th>CPMK1</th><th>CPMK2</th><th>CPMK3</th><th>CPMK4</th><th>CPMK5</th></tr>
<tr><td>CPL-1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CPL-2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CPL-3</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CPL-4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CPL-5</td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td rowspan="2">The Relationship of CPMK with Learning Materials and Forms, as well as</td><td></td><td>Learning Materials</td><td>Forms of Learning</td><td>Time Allocat</td></tr>
<tr><td>CPMK1</td><td>1. Tuition contract<br>2. Theory of gravity<br>3. Variation in g<br>4. Geoid<br>5. Gravity and potentials<br>6. Relating g to U<br>7. Gravity anomalies<br>8. Units for g</td><td>SCL and Discussion</td><td>2 Hours</td></tr>
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| **Time Allocation** | | 9. Rock density<br>10. Factor influencing rock density<br>11. Table of | | |
| | ***CPMK2*** | 1. Absolute gravity<br>2. Stable gravimeter<br>3. Unstable gravimeter<br>4. Survey design<br>5. Drift<br>6. Correcting for drift | SCL and Discussion | 2 Hours |
| | ***CPMK2*** | 1. Gravity corrections<br>2. Growth of Lithospheric plate on oceanic ridge<br>3. Latitude correction<br>4. Free-air correction<br>5. Bouguer correction<br>6. Terrain correction<br>7. Hammer Chart | SCL and Discussion | 2 Hours |
| | ***CPMK2*** | 1. Free-air anomaly<br>2. Bouguer anomaly<br>3. Field determina-tion of density<br>4. Analysis and interpretatio n<br>5. Buried sphere<br>6. Gravity anomaly map<br>7. Simple shape anomalies | SCL and Discussion | 2 Hours |
| | ***CPMK2*** | 1. Isolating gravity anomalies<br>2. Regional trend removal<br>3. Removing noise<br>4. Wavelength filtering<br>5. Spatial domain<br>6. Wave number domain | SCL and Discussion | 2 Hours |
| | ***CPMK3*** | 1. Methodology of Interpretation: general approach<br>2. Forward modeling<br>3. Inverse modeling<br>4. Salt dome<br>5. Salt dome – seismic line<br>6. Salt dome – density contrasts | SCL and Discussion | 2 Hours |

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| | | 7. Fault location<br>8. Mapping basin depth | | |
| | ***CPMK3*** | 1. Isostasy: Pratt model and Airy model<br>2. Pratt Compensation<br>3. Local and Regional Isostasy, Lithosphere Flexure<br>4. Flexural Rigidity (D)<br>5. Regional Isostasy<br>6. Strong (Thick) plate, Weak (Thin) Plate, and Plate With No Strength<br>7. Gravity Modeling (Forward) Gravity Effects<br>8. Gravity Anomaly Buried Sphere<br>9. Gravity Anomaly Infinite Slab and Semi Infinite Slab (SIS)<br>10. Gravity Anomaly and Semi Infinite Slab (SIS) Depth<br>11. Passive Continental Margin<br>12. Mountain Range<br>13. Geoid &; Mass | SCL and Discussion | 2 Hours |
| **UTS/Project Task Results/Case Analysis Results** | | | | |
| | ***CPMK3*** | IGRF and Daily Variations of Magnetic Fields | SCL and Discussion | 2 Hours |
| | ***CPMK3*** | Magnetic force, Magnetic induction, Magnetic susceptibility, Magnetic field units | SCL and Discussion | 2 Hours |
| | ***CPMK4*** | Magnetic Anomaly, Nature2 of magnetism of rocks and minerals, Rock susceptibility | SCL and Discussion | 2 Hours |
| | ***CPMK4*** | PPM, Flux-gate Magnetometer, Geomagnetic Mapping, Geomagnetic Daily | SCL and Discussion | 2 Hours |
| | ***CPMK4*** | Projection into a flat plane, | SCL and Discussion | 2 Hours |

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| | | Filtering, Local/regional anomaly separation, Vertical/Horizontal | | |
| | ***CPMK4*** | Spectrum analysis, estimated depth of anomaly sources, qualitative | Discussion | 2 Hours |
| | ***CPMK5*** | Forward and backward modeling (inversion), 2D, 2.5D, and 3D Models | SCL and Discussion | 2 Hours |

**UAS/ Project Task Results/ Case Analysis**

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| **Learning Method** | SCL and Discussion |
| **Student Learning Experience** | |
| **Access Learning Media / LMS and Offline &; Online Percentage** | LCD, Whiteboard, paper, google classroom/ internet |

**Assessment Methods and Alignment with CPMK**

| Assessment Techniques | Assessment Percentage | Criteria/ Indicators | CPMK 1 | CPMK 2 | CPMK3 | CPMK4 | CPMK5 |
|---|---|---|---|---|---|---|---|
| **Participatory Activity*)** | **10** | | | √ | | | |
| ***Project Results*/Results Case Study/ PBL Results*)** | **-** | | | | | | |
| **Cognitive** | | | | | | | |
| **Assignmen** | **-** | | | | | | |
| **Quiz** | **-** | | | | | | |
| **UTS** | **40** | | √ | √ | √ | √ | √ |
| **UAS** | **50** | | √ | √ | √ | √ | √ |
| **Total** | **100** | | | | | | |

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| | *) 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. Grant, F.S., and G.F. West, 1965, Interpretation Theory in Applied Geophysics, McGraw-Hill.<br>2. National Gravity Committee, 1992, Manual for LaCoste & Romberg Gravimeter Operators, Bakosurtanal.<br>3. Papers on gravity in journals (e.g. JGR, Geophysics, Geophysical Prospecting), Proceedings (e.g. PIT HAGI), and theses.<br>4. Parkinson, W.D., 1983. Introduction to Geomagnetism, Scottish Academic Press.<br>5. **Telford, W. M., L. P. Geldart, R.E. Sheriff, and D.A. Keys**, 1981, Applied geophysics: Cambridge, New York, U.S.A.<br>6. Telford, W.M., 1983., Applied Geophysics. Cambridge University Press.<br>7. **Torge, W.**, 1989, Gravimetry: de-Gruyter, Berlin; New York Gravimetry<br>8. Parkinson, W.D., 1983. Introduction to Geomagnetism, Scottish Academic Press. |
| **Name of Lecturer (*Team Teaching*)** | 1. Ari Setiawan<br>2. Dr. Wahyudi, M.S. |

| **Authorization** | **Drafting Date** | **Course Coordinator** | **Coordinator of Expertise (if any)** | **Head of Study Program** |
|---|---|---|---|---|
| | *3 August 2022* |  <br>*(Dr.-Ing. Ari Sewtiawan, M.Si)* | | |