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Bachelor in
Telp : +62 27
Email : kaproc
Website : http://dcse.ugm.ac.id/

UNIVERSITAS GADJAH MADA
Faculty of Mathematics and Natural Sciences
Department of Computer Science and Electronics
Sekip Utara Bulaksumur Yogyakarta 55281 Telp: +62 274 546194 Email: dep-ikc.mipa@ugm.ac.id Website: http://dcse.fmipa.ugm.ac.id

MODULE HANDBOOK

Module name	Intelligent Instrumentation and Intelligent Control
Module level, if applicable	Undergraduate
Code, if applicable	MII 3311
Courses, if applicable	Intelligent Instrumentation and Intelligent Control
Semester(s) in which the module is taught	Odd Semester
Person responsible for the module	Ika Candradewi, S.Si., M.Cs. Muhammad Idham Ananta Timur, S.T., M.Cs.
Lecturer(s)	Ika Candradewi, S.Si., M.Cs. Muhammad Idham Ananta Timur, S.T., M.Cs. Dr. Danang Lelono, M.T.
Language	English Bahasa Indonesia
Relation to curriculum	1. Undergraduate degree program, elective, 5th semester. 2. International undergraduate program, elective, 5th semester.
Teaching methods	SCL (Student Centre Learning) with team based project When Synchronized: actively discussing material and cases. When Asynchronous/Standalone/Structured Assignments: • group study • take quizzes • reflection of material (using Wiki) • reviewing literature and problems in the community • work on project ideas in a multidisciplinary manner
Workload (incl. contact hours, self-study hours)	1. Lectures: 3 x 50 = 150 minutes per week. 2. Exercises and Assignments: 2 x 50 = 100 minutes per week. 3. Self-study: 1 x 50 = 50 minutes per week.
Credit points	3 Credit Points
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.
Required and recommended prerequisites for joining the module	Students must complete Introduction to Instrumentation course (MII 1303)
Learning outcomes and their	After completing this module, a student is expected to: CO1. Mastering the concepts and principles of intelligent control

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<td>corresponding PLOs</td>
<td>
instrumentation systems, i.e fuzzy control and neural network for analysis and design of nonlinear systems, and genetic algorithm for optimization prurposes in control system design. [CPL 2]
CO2. Able to work independently showing quality and measurable performance through intelligent control instrumentation system design tasks and able to use Matlab / Simulink or python programming software to perform system simulation design results [CPL 3]
CO3. Demonstrate an attitude of responsibility for work in his area of expertise independently and can work together in teams to obtain good system design results by designing ideas to solve problems on instrumentation and control using an artificial intelligence approach: fuzzy control and neural network and optimization of control instrumentation system design [CPL 4]
CO4. Students are able to re-describe how the end-to-end learning and reinforcement learning approach works in helping the intelligent control instrumentation process. [CPL 2]
CO5. Students are able to apply several methods of end-to-end learning and reinforcement learning to help process intelligent control instrumentation. [CPL 3]
CO6. Students are able to solve several problems that arise in improving the performance of end-to-end learning and reinforcement learning methods in the control instrumentation process. [CPL 4]
<table>
<tr><th colspan="2">PLO</th><th>CO1</th><th>CO2</th><th>CO3</th><th>CO4</th><th>CO5</th><th>CO6</th></tr>
<tr><td rowspan="5">Program Learning Outcome (PLO)</td><td>PLO1</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PLO2</td><td>√</td><td></td><td></td><td>√</td><td></td><td></td></tr>
<tr><td>PLO3</td><td></td><td>√</td><td></td><td></td><td>√</td><td></td></tr>
<tr><td>PLO4</td><td></td><td></td><td>√</td><td></td><td></td><td>√</td></tr>
<tr><td>PLO5</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr>
<td>Content</td>
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1. Introduction to intelligent control instrumentation
2. Fuzzy logic and Fuzzy System
3. Tagaki – Sugeno Fuzzy Model
4. Fuzzy Control Application on the Pendulum-Cart System
5. Synthesis of Fuzzy Control
6. Neural Network and Its Application in Control
7. Optimization using the Genetic Algorithm Technique

Case study :
a. Olfactory and Taste with Intelligent Sensors
b. Vision and Touch Sensing Systems for Soft Object Interaction
c. Intelligent control system design

End-to-End Learning for Autonomous Cars
a. Basic concepts of Deep Learning
b. Improves Deep Learning performance

Introduction to Reinforcement Learning
a. The basic concept of RL, state, action, reward
b. Markov Decision Process
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<tr><td></td><td>Q-Learning and the Reinforcement Learning Approach
a. Exploration vs Exploitation
b. Epsilon Greedy
c. On Policy vs Off Policy
d. Reinforcement Learning Algorithm

Actor Critic and Traffic Light Instrumentation Cases
a. Continuous action
b. A2C, A3C
c. Traffic Light Instrumentation</td></tr>
<tr><td>Study and examination requirements and examination forms</td><td>The evaluation is done in Five forms, namely:
1. Final exam
2. Midterm exam
3. Quiz
4. Assignments / Task
5. Case based Project</td></tr>
<tr><td>Media employed</td><td>e-learning Platform (ELOK), projector, whiteboard, and presentation.</td></tr>
<tr><td>Assessments and evaluation</td><td>
<table>
<tr><th>Type</th><th>Percentage</th><th>CO1</th><th>CO2</th><th>CO3</th><th>CO4</th><th>CO5</th><th>CO6</th></tr>
<tr><td>Project Results/Case Study Results/PBL Results*)</td><td>30%</td><td></td><td></td><td>√</td><td></td><td></td><td>√</td></tr>
<tr><td>Task (Skill-based Assessment (SBA)) Structured Assignments</td><td>20%</td><td>√</td><td>√</td><td></td><td>√</td><td>√</td><td></td></tr>
<tr><td>Quiz</td><td>10%</td><td>√</td><td></td><td></td><td>√</td><td></td><td></td></tr>
<tr><td>Midterm Exam – Theoritical & Analysis</td><td>20 %</td><td>√</td><td>√</td><td>√</td><td></td><td></td><td></td></tr>
<tr><td>Final Exam – Theoritical & Analysis</td><td>20 %</td><td></td><td></td><td></td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Total</td><td>100 %</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Reading list</td><td>Main References :

[1] Bhyuan, M., 2010, Intelligent Instrumentation Principles and Application, CRC Press, London, New York

[2] Kevin M. Passino and Stephen Yurkovich, “Fuzzy Control,” Addison-Wesley</td></tr>
</table>

	Longman Inc., 1998. [3] Kazuo Tanaka, Hua O. Wang, "Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach," John Wiley & Sons, 2001 [4] Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach," 3rd Edition., Pearson Education, Inc., 2010 [5] Melanie Mitchell., An Introduction to Genetic Algorithms., the MIT press, 1996 [6] Stephen I. Gallant, "Neural Network Learning and Expert Systems," the MIT press, London,1993 [6] Taweh Beysolow II, 2019, ***Applied Reinforcement Learning with Python, Apress*** **Additional references:** [1] Mukhopadhyay, S.C, 2013, Intelligent Sensing, Instrumentation, and Measurement, Springer, New York [2] Leung, H. and Mukhopadhyay, S.C, 2015, Intelligent Environmental Sensing, Springer, New York.

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