

# MODULE HANDBOOK

## BIOMEDICAL SENSORS AND TRANSDUCERS



**BACHELOR DEGREE PROGRAM  
DEPARTMENT OF BIOMEDICAL ENGINEERING  
FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS  
TECHNOLOGY**

**INSTITUT TEKNOLOGI SEPULUH NOPEMBER**



# MODULE HANDBOOK


## Biomedical Sensors and Transducers

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| Module name                                           | <b>Biomedical Sensors and Transducers</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                         |
| Module level                                          | Undergraduate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                         |
| Code                                                  | EB184502                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                         |
| Course (if applicable)                                | Biomedical Sensors and Transducers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                         |
| Semester                                              | First Semester (Gasal)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                         |
| Person responsible for the module                     | M. Hilman Fatoni, S.T., M.T.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                         |
| Lecturer                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         |
| Language                                              | Bahasa Indonesia and English                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                         |
| Relation to curriculum                                | Undergraduate degree program, <b>mandatory</b> , 5 <sup>th</sup> semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                         |
| Type of teaching, contact hours                       | Lectures, < 60 students<br>Wednesdays, 14.00-16.50 (GMT+7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                         |
| Workload                                              | <ol style="list-style-type: none"> <li>1. Lectures : 2 x 50 = 100 minutes per week.</li> <li>2. Exercises and Assignments : 2 x 60 = 120 minutes (2 hours) per week.</li> <li>3. Private learning : 2 x 60 = 120 minutes (2 hours) per week.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                         |
| Credit points                                         | 3 credit points (sks)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                         |
| Requirements according to the examination regulations | A student must have attended at least 75% of the lectures to sit in the exams.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                         |
| Mandatory prerequisites                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                         |
| Learning outcomes and their corresponding PLOs        | <p>Course Learning Outcome (CLO) after completing this module,</p> <p>CLO 1 : Students are able to understand, explain, calculate and analyze the parameters in sensors and transducers</p> <p>CLO 2 : Students are able to understand and explain the stage of sensor design in general through a phenomenon approach and material analogy</p> <p>CLO 3 : Students are able to understand and explain the principles of resistive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</p> <p>CLO 4 : Students are able to understand and explain the</p> | <p>PLO-02</p> <p>PLO-01</p> <p>PLO-05</p> <p>PLO-05</p> |

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|                                                             | <p>principles of inductive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</p> <p>CLO 5 : Students are able understand and explain the principles of capacitive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</p> <p>CLO 6 : Students are able to undertand and explain the principles of optical-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</p> <p>CLO 7 : Students are able to undertand and explain the principles of acoustic-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</p> | <p>PLO-05</p> <p>PLO-05</p> <p>PLO-05</p> |
| Content                                                     | This course studies the sensor’s parameters, resistive-based sensor principles, inductive-based sensor principles, capacitive-based sensor principles, optical-based sensors principles, acoustice-based sensor principles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                           |
| Study and examination requirements and forms of examination | <ul style="list-style-type: none"> <li>• In-class exercises</li> <li>• Assignment 1, 2, 3, 4, 5, 6, 7</li> <li>• Mid-term examination</li> <li>• Final examination</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                           |
| Media employed                                              | LCD, whiteboard, websites (myITS Classroom), zoom.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                           |
| Reading list                                                | <p>Main :</p> <ol style="list-style-type: none"> <li>1. Joseph J. Carr, “Sensor and Circuits : Sensors, Transducers, and Suporting Circuits for Electronic Instrumentation, Measurement and Control”, T R Prentice Hall, Englewood Cliffs, New Jersey, 1993</li> <li>2. Barry E Jones, “Instrumentation Measurement and Feedback, TMH Edition”, McGraw-Hill Book Company (UK) Limited, 1978</li> </ol> <p>Supporting :</p> <ol style="list-style-type: none"> <li>3. L E Kinsler, “Fundamental of Acoustics, Second Edition”, John Wiley &amp; Sons, Inc New York, Chichester, Brisbane and Toronto, 1962</li> <li>4. Frederick W. Kremkau, Diagnostic Ultrasound: Principles, Instrumentation, and Exercises, Second Edition”, Grune &amp; Stration, Inc, 1984</li> <li>5. Bela G. Liptak, Kriszta Venczel, “Process Measurement:</li> </ol>                                                                                                                                                                                                                                                                    |                                           |

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|  | Instrument Engineers Handbook, Revised Edition", Bela G, Liptak, 1969 |
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**I. Rencana Pembelajaran Semester / Semester Learning Plan**

|    |                                                                                      | <b>INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS)</b><br><b>FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS TECHNOLOGY</b><br><b>BIOMEDICAL ENGINEERING DEPARTMENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                             |     |                                                   | <b>Document Code</b>                            |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-----|---------------------------------------------------|-------------------------------------------------|
| <b>SEMESTER LEARNING PLAN</b>                                                       |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                             |     |                                                   |                                                 |
| <b>MATA KULIAH (MK)</b><br><b>COURSE</b>                                            | <b>KODE</b><br><b>CODE</b>                                                           | <b>Rumpun MK</b><br><b>Course Cluster</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>BOBOT (sks)</b><br><b>Credits</b>                        |     | <b>SEMESTER</b>                                   | <b>Tgl Penyusunan</b><br><b>Completion Date</b> |
| <b>Sensor dan Transduser Biomedika</b><br><b>Biomedical Sensors and Transducers</b> | EB184502                                                                             | Biomedical Instrumentation and Signal Processing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | T=3                                                         | P=0 | V                                                 | 27 Juni 2020                                    |
| <b>OTORISASI / PENGESAHAN</b><br><b>AUTHORIZATION / ENDORSEMENT</b>                 | <b>Dosen Pengembang RPS</b><br><b>Developer Lecturer of Semester Learning Plan</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Koordinator RMK</b><br><b>Course Cluster Coordinator</b> |     | <b>Ka DEPARTEMEN</b><br><b>Head of Department</b> |                                                 |
|                                                                                     | (M. Hilman Fatoni, S.T., M.T.)                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | (Dr. Rachmad Setiawan, S.T., M.T.)                          |     | (Dr. Achmad Arifin, S.T., M.Eng.)                 |                                                 |
| <b>Capaian Pembelajaran</b><br><b>Learning Outcomes</b>                             | <b>CPL-PRODI yang dibebankan pada MK</b><br><b>PLO Program Charged to The Course</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                             |     |                                                   |                                                 |
|                                                                                     | <b>CPL-01</b><br><b>PLO-01</b>                                                       | Mampu <b>menerapkan</b> Ilmu Pengetahuan Alam dan Matematika pada bidang Teknik Biomedika<br><i>Able to apply Natural Sciences and Mathematics in the field of Biomedical Engineering</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                             |     |                                                   |                                                 |
|                                                                                     | <b>CPL-02</b><br><b>PLO-02</b>                                                       | Mampu <b>menemukan, memahami, menjelaskan, merumuskan, dan menyelesaikan</b> permasalahan umum pada bidang Teknik dan permasalahan khusus pada bidang Teknik Biomedika yang meliputi instrumentasi biomedika cerdas, teknik rehabilitasi medika, pencitraan dan pengolahan citra medika, serta informatika medika.<br><i>Able to find, understand, explain, formulate, and solve general problems in the field of Engineering and special problems in the field of Biomedical Engineering which includes intelligent biomedical instrumentation, medical rehabilitation techniques, imaging and processing of medical images, and medical informatics.</i> |                                                             |     |                                                   |                                                 |
|                                                                                     | <b>CPL-05</b>                                                                        | Mampu <b>mendesain</b> komponen, sistem, dan proses dalam bidang Teknik Biomedika yang sistematis, logis, dan realistis sesuai dengan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                             |     |                                                   |                                                 |

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| <b>PLO-05</b>                                                                                                                                                                           | <p>spesifikasi yang ditentukan dengan mempertimbangkan aspek keselamatan, sosial, budaya, lingkungan, dan ekonomi dengan <b>mengenal/memanfaatkan</b> sumber daya lokal dan nasional dengan wawasan global.</p> <p><i>Able to <b>design</b> components, systems, and processes in the field of Biomedical Engineering that are systematic, logical, and realistic appropriate with specified specifications by considering aspects of safety, social, cultural, environmental, and economic by <b>recognizing</b> / <b>utilizing</b> local and national resources with global insight.</i></p> |
| <p><b>Capaian Pembelajaran Mata Kuliah (CPMK)</b><br/> <b>Course Learning Outcome (CLO) – if CLO as description capability of each Learning Stage in the course, then CLO = LLO</b></p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>CP MK 1</b><br><b>CLO 1</b>                                                                                                                                                          | <p>Mahasiswa mampu memahami, menjelaskan, menghitung dan menganalisa parameter-parameter pada sensor dan transduser</p> <p><i>Students are able to understand, explain, calculate and analyze the parameters in sensors and transducers</i></p>                                                                                                                                                                                                                                                                                                                                                |
| <b>CP MK 2</b><br><b>CLO 2</b>                                                                                                                                                          | <p>Mahasiswa mampu memahami dan menjelaskan tahapan perancangan sensor secara umum melalui pendekatan fenomena dan analogi bahan</p> <p><i>Students are able to understand and explain the stage of sensor design in general through a phenomenon approach and material analogy</i></p>                                                                                                                                                                                                                                                                                                        |
| <b>CP MK 3</b><br><b>CLO 3</b>                                                                                                                                                          | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis resistif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able to understand and explain the principles of resistive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p>                       |
| <b>CP MK 4</b><br><b>CLO 4</b>                                                                                                                                                          | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis induktif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able understand and explain the principles of inductive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p>                          |
| <b>CP MK 5</b><br><b>CLO 5</b>                                                                                                                                                          | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis kapasitif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able understand and explain the principles of capacitive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p>                        |
| <b>CP MK 6</b>                                                                                                                                                                          | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis optikal, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal</p>                                                                                                                                                                                                                                                                                                                                        |

|                                                                           | <b>CLO 6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | dari sensor tersebut<br>Students are able to understand and explain the principles of optical-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors                                                                                                                                                                                                                                                          |        |        |        |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
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|                                                                           | <b>CP MK 7</b><br><br><b>CLO 7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis akustik, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut<br><i>Students are able to understand and explain the principles of acoustic-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i> |        |        |        |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| <b>Peta CPL – CP MK</b><br><br><b>Map of PLO - CLO</b>                    | <table border="1"> <thead> <tr> <th></th> <th>CPL-01</th> <th>CPL-02</th> <th>CPL-03</th> <th>CPL-04</th> <th>CPL-05</th> <th>CPL-06</th> <th>CPL-07</th> <th>CPL-08</th> <th>CPL-09</th> <th>CPL-10</th> <th>CPL-11</th> <th>CPL-12</th> </tr> </thead> <tbody> <tr> <td>CPMK 1 / SUB CPMK 1<br/>CLO 1 / LLO 1</td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 2 / SUB CPMK 2<br/>CLO 2 / LLO 2</td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 3 / SUB CPMK 3<br/>CLO 3 / LLO 3</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 4 / SUB CPMK 4<br/>CLO 4 / LLO 4</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 5 / SUB CPMK 5<br/>CLO 5 / LLO 5</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 6 / SUB CPMK 6<br/>CLO 6 / LLO 6</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CPMK 6 / SUB CPMK 6<br/>CLO 6 / LLO 6</td> <td></td> <td></td> <td></td> <td></td> <td>√</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |        |        |        |        |        |        |        |  | CPL-01 | CPL-02 | CPL-03 | CPL-04 | CPL-05 | CPL-06 | CPL-07 | CPL-08 | CPL-09 | CPL-10 | CPL-11 | CPL-12 | CPMK 1 / SUB CPMK 1<br>CLO 1 / LLO 1 |  | √ |  |  |  |  |  |  |  |  |  |  | CPMK 2 / SUB CPMK 2<br>CLO 2 / LLO 2 | √ |  |  |  |  |  |  |  |  |  |  |  | CPMK 3 / SUB CPMK 3<br>CLO 3 / LLO 3 |  |  |  |  | √ |  |  |  |  |  |  |  | CPMK 4 / SUB CPMK 4<br>CLO 4 / LLO 4 |  |  |  |  | √ |  |  |  |  |  |  |  | CPMK 5 / SUB CPMK 5<br>CLO 5 / LLO 5 |  |  |  |  | √ |  |  |  |  |  |  |  | CPMK 6 / SUB CPMK 6<br>CLO 6 / LLO 6 |  |  |  |  | √ |  |  |  |  |  |  |  | CPMK 6 / SUB CPMK 6<br>CLO 6 / LLO 6 |  |  |  |  | √ |  |  |  |  |  |  |  |
|                                                                           | CPL-01                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | CPL-02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CPL-03 | CPL-04 | CPL-05 | CPL-06 | CPL-07 | CPL-08 | CPL-09 | CPL-10 | CPL-11 | CPL-12 |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 1 / SUB CPMK 1<br>CLO 1 / LLO 1                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | √                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |        |        |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 2 / SUB CPMK 2<br>CLO 2 / LLO 2                                      | √                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 3 / SUB CPMK 3<br>CLO 3 / LLO 3                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        | √      |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 4 / SUB CPMK 4<br>CLO 4 / LLO 4                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        | √      |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 5 / SUB CPMK 5<br>CLO 5 / LLO 5                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        | √      |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 6 / SUB CPMK 6<br>CLO 6 / LLO 6                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        | √      |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| CPMK 6 / SUB CPMK 6<br>CLO 6 / LLO 6                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        | √      |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |
| <b>Diskripsi Singkat MK</b><br><br><b>Short Description of The Course</b> | <p>Mata kuliah Sensor dan Transduser Biomedika merupakan mata kuliah wajib yang membahas tentang konsep dasar perancangan dan penggunaan sensor dan transduser yang banyak digunakan khususnya dalam bidang biomedik. Mata kuliah ini bertujuan agar mahasiswa mampu memahami, merancang dan menganalisa peralatan medis berbasis sensor dan transduser. Dengan pemahaman dan keterampilan tersebut, mahasiswa diharapkan mampu menerapkannya terutama pada disiplin ilmu biomedik.</p> <p><i>Biomedical Sensors and Transducers course is a mandatory subject which discusses about basic design concepts and use of sensors as well as transducers especially in biomedical field. This course aims for the student to be able to understand, design and analyze sensor and transducer based</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |        |        |        |        |        |        |        |  |        |        |        |        |        |        |        |        |        |        |        |        |                                      |  |   |  |  |  |  |  |  |  |  |  |  |                                      |   |  |  |  |  |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |                                      |  |  |  |  |   |  |  |  |  |  |  |  |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <i>medical equipment. With the understanding of these skills, students are expected to be able to implement it especially in biomedical discipline.</i>                                                                                                                                                                                                                                                                                                                                                                                                  |                              |                                                  |                                      |                        |
| <b>Bahan Kajian:</b><br>Materi pembelajaran<br><br><b>Course Materials:</b>                                                                                                                                                                                                                                                                                                                                                                                                               | <ol style="list-style-type: none"> <li>1. Parameter sensor / <i>Sensor's parameters</i></li> <li>2. Prinsip sensor berbasis resistif / <i>Resistive-based sensor principles</i></li> <li>3. Prinsip sensor berbasis resistif / <i>Inductive-based sensor principles</i></li> <li>4. Prinsip sensor berbasis resistif / <i>Capacitive-based sensor principles</i></li> <li>5. Prinsip sensor berbasis resistif / <i>Optical-based sensor principles</i></li> <li>6. Prinsip sensor berbasis resistif / <i>Acoustic-based sensor principles</i></li> </ol> |                              |                                                  |                                      |                        |
| <b>Pustaka</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>Utama / Main:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                                                  |                                      |                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <ol style="list-style-type: none"> <li>1. Joseph J. Carr, "Sensor and Circuits : Sensors, Transducers, and Suporting Circuits for Electronic Instrumentation, Measurement and Control", T R Prentice Hall, Englewood Cliffs, New Jersey, 1993</li> <li>2. Barry E Jones, "Instrumentation Measurement and Feedback, TMH Edition", McGraw-Hill Book Company (UK) Limited, 1978</li> </ol>                                                                                                                                                                 |                              |                                                  |                                      |                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Pendukung / Supporting:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                              |                                                  |                                      |                        |
| <ol style="list-style-type: none"> <li>1. L E Kinsler, "Fundamental of Acoustics, Second Edition", John Wiley &amp; Sons, Inc New York, Chichester, Brisbance and Toronto, 1962</li> <li>2. Frederick W. Kremkau, Diagnostic Ultrasound: Principles, Instrumentation, and Exercises, Second Edition", Grune &amp; Stration, Inc, 1984</li> <li>3. Bela G. Liptak, Kriszta Venczel, "Process Measurement: Instrument Engineers Handbook, Revised Edition", Bela G, Liptak, 1969</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                                                  |                                      |                        |
| <b>Dosen Pengampu</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                                                  |                                      |                        |
| <b>Matakuliah syarat</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                              |                                                  |                                      |                        |
| <b>Mg Ke / Week</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>Kemampuan akhir tiap tahapan belajar (Sub-CPMK)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Penilaian / Assesment</b> | <b>Bantuk Pembelajaran; Metode Pembelajaran;</b> | <b>Materi Pembelajaran [Pustaka]</b> | <b>Bobot Penilaian</b> |

|       | <i>/<br/>Final ability of each Learning<br/>stage (LLO)</i>                                                                                                                                                                                     | <i>Indikator /<br/>Indicator</i>                                                                                                                                                                                                                                                                                         | <i>Kriteria &amp; Teknik /<br/>Criteria &amp;<br/>Techniques</i>                                                                                                                                                                                                                                                                                       | <i>Penugasan Mahasiswa;<br/>[ Estimasi Waktu] /<br/>Form of Learning; Learning Methods;<br/>Student Assignment;<br/>[ Estimated Time]</i>                                                                                                             |                                                                                                                                                               | <i>/<br/>Learning Materials<br/>[Reference]</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <i>(%)<br/>/<br/>Assessm-<br/>ent Load<br/>(%)</i> |
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| (1)   | (2)                                                                                                                                                                                                                                             | (3)                                                                                                                                                                                                                                                                                                                      | (4)                                                                                                                                                                                                                                                                                                                                                    | Tatap Muka (5)                                                                                                                                                                                                                                        | Daring (6)                                                                                                                                                    | (7)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | (8)                                                |
| 1 - 2 | <p>Mahasiswa mampu memahami, menjelaskan, menghitung dan menganalisa parameter-parameter pada sensor dan transduser</p> <p><i>Students are able to understand, explain, calculate and analyze the parameters in sensors and transducers</i></p> | <ul style="list-style-type: none"> <li>• Mampu menjelaskan dan membedakan sensor dan transduser</li> <li>• Mampu menganalisa dan mengukur sensor dan transduser</li> <li>• <i>Able to explain and differentiate sensor and transducer</i></li> <li>• <i>Able to analyse and measure sensor and transducer</i></li> </ul> | <p><b>Non-tes :</b><br/><b>Tugas 1 :</b><br/>Analisa dan menghitung parameter-parameter pada sensor (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal ETS 1</p> <p><b>Non-test :</b><br/><b>Task 1 :</b><br/><i>Analyzing and calculating sensor's parameters (Written assignment)</i></p> <p><b>Test :</b><br/><i>Mid-term examination question 1</i></p> | <ul style="list-style-type: none"> <li>• Kuliah dan brainstorming, tanya jawab [TM : 3 x 50"] [BM : 3 x 50"] [PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and answer. [FF : 3 x 50"] [SA : 3 x 50"] [SS : 3 x 50"]</i></li> </ul> | <ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>• Kontrak kuliah: <ul style="list-style-type: none"> <li>- Motivasi belajar</li> <li>- Rencana pembelajaran</li> <li>- Aturan-aturan perkuliahan</li> <li>- Tujuan perkuliahan</li> <li>- Sistem penilaian, buku ajar/sumber pustaka</li> </ul> </li> <li>• Defenisi: <ul style="list-style-type: none"> <li>- transduser (aktif dan pasif)</li> <li>- Sensor</li> <li>- Aktuator</li> <li>- Probe</li> <li>- Elektroda</li> </ul> </li> <li>• Parameter pada sensor</li> <li>• Analisa dan perhitungan pada sensor</li> <li>• Metode</li> </ul> | 7.5                                                |

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|  |  |  |  |  |  | <p>pengukuran (direct, indirect, inferential)</p> <ul style="list-style-type: none"> <li>• <i>Course contract :</i> <ul style="list-style-type: none"> <li>- <i>Motivation to learn</i></li> <li>- <i>Lesson plan</i></li> <li>- <i>Lectures rules</i></li> <li>- <i>Course objective</i></li> <li>- <i>Assessment system, textbooks / library resources</i></li> </ul> </li> <li>• <i>Defenition :</i> <ul style="list-style-type: none"> <li>- <i>Transducers (active and pasive)</i></li> <li>- <i>Sensor</i></li> <li>- <i>Actuator</i></li> <li>- <i>Probe</i></li> <li>- <i>Electrode</i></li> </ul> </li> <li>• <i>Sensor's parameters</i></li> <li>• <i>Sensor analysis and calculation</i></li> <li>• <i>Measurement method (dircet, indirect,</i></li> </ul> |  |
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|              |                                                                                                                                                                                                                                                                                         |                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                               | <i>inferential)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |
| <b>3 - 4</b> | <p>Mahasiswa mampu memahami dan menjelaskan tahapan perancangan sensor secara umum melalui pendekatan fenomena dan analogi bahan</p> <p><i>Students are able to understand and explain the stage of sensor design in general through a phenomenon approach and material analogy</i></p> | <ul style="list-style-type: none"> <li>• Mampu merancang sensor dan transduser</li> <li>• <i>Able to design sensor and transducer</i></li> </ul> | <p><b>Non-tes :</b><br/><b>Tugas 2</b><br/>Perancangan sensor secara umum melalui pendekatan fenomena dan analogi bahan (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal ETS 2</p> <p><b>Non-test :</b><br/><b>Task 2 :</b><br/><i>Sensor design in general through phenomenal approach and material analogy (Written assignment)</i></p> <p><b>Test :</b><br/><i>Mid-term examination question 2</i></p> | <ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom<br/><br/>[TM : 3 x 50"]<br/>[BM : 3 x 50"]<br/>[PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and answer.</i><br/>[FF : 3 x 50"]<br/>[SA : 3 x 50"]<br/>[SS : 3 x 50"]</li> </ul> | <ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>• Tahap perancangan secara umum : <ul style="list-style-type: none"> <li>- Karakterisasi bahan (sensor dan transduser)</li> <li>- Fenomena alam dan analogi bahan (sensor dan transduser)</li> <li>- Diagram blok dan skematik transduser standar industri dan medis</li> </ul> </li> <li>• <i>Design stage in general :</i> <ul style="list-style-type: none"> <li>- Material characterization (sensor and transducer)</li> <li>- Natural phenomena and material</li> </ul> </li> </ul> | <b>7.5</b> |

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|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                           | analogy<br>(sensor and transducer)<br>- Schematic and block diagram of standard transducer in medical and industry field                                                                                                                                                                                                                                                                                                                                                                                              |     |
| 5 - 6 | Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis resistif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut<br><br><i>Students are able to understand and explain the principles of resistive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning</i> | <ul style="list-style-type: none"> <li>Mampu menjelaskan dan merancang sensor berbasis resistif</li> <li><i>Able to explain and design resistive-based sensor</i></li> </ul> | <b>Non-tes :</b><br><b>Tugas 3:</b><br>Mengenai prinsip sensor berbasis resistif, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)<br><br><b>Tes :</b><br>Soal ETS 3<br><br><b>Non-test :</b><br><b>Task 3 :</b><br><i>About resistive-based sensor principles, its types, signal conditioning</i> | <ul style="list-style-type: none"> <li>Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom<br/><br/>           [TM : 3 x 50"]<br/>           [BM : 3 x 50"]<br/>           [PT : 3 x 50"]</li> <li><i>Presentation and brainstorming, ask and answer.</i><br/>           [FF : 3 x 50"]<br/>           [SA : 3 x 50"]<br/>           [SS : 3 x 50"]</li> </ul> | <ul style="list-style-type: none"> <li>Chatting dan diskusi dalam forum platform ITS</li> <li><i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>Sensor berbasis resistif :           <ul style="list-style-type: none"> <li>Konsep dasar</li> <li>Cara kerja</li> <li>Tipe</li> <li>Metode pengukuran</li> <li>Perancangan rangkaian pengkondisi sinyal</li> <li>Contoh aplikasi dalam instrumen medis</li> </ul> </li> <li><i>Resistive-based sensor :</i> <ul style="list-style-type: none"> <li><i>Basic concepts</i></li> <li><i>How it works</i></li> <li><i>Types</i></li> <li><i>Measurement</i></li> </ul> </li> </ul> | 7.5 |

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|             | <i>from these sensors</i>                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  | <p><i>circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/><i>Mid-term examination question 3</i></p>                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                               | <p><i>method</i></p> <ul style="list-style-type: none"> <li>- <i>Signal conditioning circuit design</i></li> <li>- <i>Application in medical instrument</i></li> </ul>                                                                                                                                                                                              |            |
| <b>7, 9</b> | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis induktif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able understand and explain the principles of inductive-based sensors, their types, their general applications and specifically in</i></p> | <ul style="list-style-type: none"> <li>• Mampu menjelaskan dan merancang sensor berbasis induktif</li> <li>• <i>Able to explain and design inductive-based sensor</i></li> </ul> | <p><b>Non-tes :</b><br/><b>Tugas 4:</b><br/>Mengenai prinsip sensor berbasis induktif, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal ETS 4</p> <p><b>Non-test :</b><br/><b>Task 4 :</b></p> | <ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom</li> </ul> <p>[TM : 3 x 50"]<br/>[BM : 3 x 50"]<br/>[PT : 3 x 50"]</p> <ul style="list-style-type: none"> <li>• <i>Presentation and brainstorming, ask and answer.</i></li> </ul> <p>[FF : 3 x 50"]<br/>[SA : 3 x 50"]<br/>[SS : 3 x 50"]</p> | <ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>• Sensor berbasis induktif : <ul style="list-style-type: none"> <li>- Konsep dasar</li> <li>- Cara kerja</li> <li>- Tipe</li> <li>- Metode pengukuran</li> <li>- Perancangan rangkaian pengkondisi sinyal</li> <li>- Contoh aplikasi dalam instrumen medis</li> </ul> </li> <li>• <i>Inductive-based sensor :</i></li> </ul> | <b>7.5</b> |

|                |                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                    |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                |                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                     |            |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
|                | <i>medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i>                                                                                                                                                                                          |                                                                                                                                                                                    | <i>About inductive-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i><br><br><b>Test :</b><br><i>Mid-term examination question 4</i>          |                                                                                                                                                                                                                                                |                                                                                                                                                               | <ul style="list-style-type: none"> <li>- <i>Basic concepts</i></li> <li>- <i>How it works</i></li> <li>- <i>Types</i></li> <li>- <i>Measurement method</i></li> <li>- <i>Signal conditioning circuit design</i></li> <li>- <i>Application in medical instrument</i></li> </ul>                                      |            |
| <b>8</b>       | <b>EVALUASI TENGAH SEMESTER</b>                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                    |                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                |                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                     | <b>20</b>  |
| <b>10 - 11</b> | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis kapasitif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able understand</i></p> | <ul style="list-style-type: none"> <li>• Mampu menjelaskan dan merancang sensor berbasis kapasitif</li> <li>• <i>Able to explain and design capacitive-based sensor</i></li> </ul> | <p><b>Non-tes :</b><br/><b>Tugas 5:</b><br/>Mengenai prinsip sensor berbasis kapasitif, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b></p> | <ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom<br/><br/>[TM : 3 x 50"]<br/>[BM : 3 x 50"]<br/>[PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and</i></li> </ul> | <ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>• Sensor berbasis kapasitif : <ul style="list-style-type: none"> <li>- Konsep dasar</li> <li>- Cara kerja</li> <li>- Tipe</li> <li>- Metode pengukuran</li> <li>- Perancangan rangkaian pengkondisi sinyal</li> <li>- Contoh aplikasi dalam instrumen</li> </ul> </li> </ul> | <b>7.5</b> |

|         |                                                                                                                                                                                                                                                                       |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                |                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                   |     |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|         | <i>and explain the principles of capacitive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i>                  |                                                                                                                                                                                | <p>Soal EAS 1</p> <p><b>Non-test :</b><br/><b>Task 5 :</b><br/><i>About capacitive-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/><i>Final examination question 1</i></p> | <p><i>answer.</i><br/><i>[FF : 3 x 50"]</i><br/><i>[SA : 3 x 50"]</i><br/><i>[SS : 3 x 50"]</i></p>                                                                                                                                            |                                                                                                                                                               | <p>medis</p> <ul style="list-style-type: none"> <li>• <i>Capacitive-based sensor :</i> <ul style="list-style-type: none"> <li>- <i>Basic concepts</i></li> <li>- <i>How it works</i></li> <li>- <i>Types</i></li> <li>- <i>Measurement method</i></li> <li>- <i>Signal conditioning circuit design</i></li> <li>- <i>Application in medical instrument</i></li> </ul> </li> </ul> |     |
| 12 - 13 | Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis optikal, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut | <ul style="list-style-type: none"> <li>• Mampu menjelaskan dan merancang sensor berbasis optikal</li> <li>• <i>Able to explain and design optical-based sensor)</i></li> </ul> | <p><b>Non-tes :</b><br/><b>Tugas 6:</b><br/>Mengenai prinsip sensor berbasis optikal, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b></p>                                                            | <ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom<br/><br/>[TM : 3 x 50"]<br/>[BM : 3 x 50"]<br/>[PT : 3 x 50"]</li> <li>• <i>Presentation and brainstorming, ask and</i></li> </ul> | <ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>• Sensor berbasis optikal : <ul style="list-style-type: none"> <li>- Konsep dasar</li> <li>- Cara kerja</li> <li>- Tipe</li> <li>- Metode pengukuran</li> <li>- Perancangan rangkaian pengkondisi sinyal</li> <li>- Contoh aplikasi dalam instrumen</li> </ul> </li> </ul>                                                                 | 7.5 |




|         |                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                     |                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                |     |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|         | <p><i>Students are able to understand and explain the principles of optical-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p>                        |                                                                                                                                                                                 | <p>Soal EAS 2</p> <p><b>Non-test :</b><br/><b>Task 5 :</b><br/><i>About optical-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/><i>Final examination question 2</i></p> | <p><i>answer.</i><br/><i>[FF : 3 x 50"]</i><br/><i>[SA : 3 x 50"]</i><br/><i>[SS : 3 x 50"]</i></p>                                                                                                                                                                 |                                                                                                                                                               | <p>medis</p> <ul style="list-style-type: none"> <li>• <i>Optical-based sensor :</i> <ul style="list-style-type: none"> <li>- <i>Basic concepts</i></li> <li>- <i>How it works</i></li> <li>- <i>Types</i></li> <li>- <i>Measurement method</i></li> <li>- <i>Signal conditioning circuit design</i></li> <li>- <i>Application in medical instrument</i></li> </ul> </li> </ul> |     |
| 14 - 15 | <p>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis akustik, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><i>Students are able to</i></p> | <ul style="list-style-type: none"> <li>• Mampu menjelaskan dan merancang sensor berbasis akustik</li> <li>• <i>Able to explain and design acoustic-based sensor)</i></li> </ul> | <p><b>Non-tes :</b><br/><b>Tugas 7:</b><br/>Mengenai prinsip sensor berbasis akustik, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b></p>                                                         | <ul style="list-style-type: none"> <li>• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom</li> <li><i>[TM : 3 x 50"]</i><br/><i>[BM : 3 x 50"]</i><br/><i>[PT : 3 x 50"]</i></li> <li>• <i>Presentation and brainstorming, ask and</i></li> </ul> | <ul style="list-style-type: none"> <li>• Chatting dan diskusi dalam forum platform ITS</li> <li>• <i>Chat and discussion in ITS platform forum</i></li> </ul> | <ul style="list-style-type: none"> <li>• Sensor berbasis akustik : <ul style="list-style-type: none"> <li>- Konsep dasar</li> <li>- Cara kerja</li> <li>- Tipe</li> <li>- Metode pengukuran</li> <li>- Perancangan rangkaian pengkondisi sinyal</li> <li>- Contoh aplikasi dalam instrumen</li> </ul> </li> </ul>                                                              | 7.5 |

|           |                                                                                                                    |  |                                                                                                                                                                                                                                                                                        |                                                                                   |  |                                                                                                                                                                                                                                                                                                                                                                                 |             |
|-----------|--------------------------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
|           | <i>undertand and explain the principles of acoustic-based sensors, their types, their general applications and</i> |  | <p>Soal EAS 3</p> <p><b>Non-test :</b><br/> <b>Task 5 :</b><br/> <i>About acoustic-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/> <i>Final examination question 3</i></p> | <p><i>answer.</i><br/> [FF : 3 x 50"]<br/> [SA : 3 x 50"]<br/> [SS : 3 x 50"]</p> |  | <p>medis</p> <ul style="list-style-type: none"> <li>• <i>acoustic-based sensor :</i> <ul style="list-style-type: none"> <li>- <i>Basic concepts</i></li> <li>- <i>How it works</i></li> <li>- <i>Types</i></li> <li>- <i>Measurement method</i></li> <li>- <i>Signal conditioning circuit design</i></li> <li>- <i>Application in medical instrument</i></li> </ul> </li> </ul> |             |
| <b>16</b> | <b>EVALUASI AKHIR SEMESTER</b>                                                                                     |  |                                                                                                                                                                                                                                                                                        |                                                                                   |  |                                                                                                                                                                                                                                                                                                                                                                                 | <b>27.5</b> |

TM=Tatap Muka, PT=Penugasan Terstruktur, BM=Belajar Mandiri.

## II. Rencana Asesmen & Evaluasi (RAE)/ *Assessment & Evaluation Plan*

|                                                                                   |                                                                                                                                                                       |                                                                                                                                                |                                                                         |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
|  | <b>ASSESSMENT &amp; EVALUATION PLAN</b><br><b>BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING – FTEIC ITS</b><br><b>Course : Biomedical Sensors and Transducers</b> |                                                                                                                                                | <b>RA&amp;E</b>                                                         |
|                                                                                   |                                                                                                                                                                       |                                                                                                                                                | Write Doc Code                                                          |
| <b>Kode / Code :</b><br><b>EB184502</b>                                           | <b>Bobot sks / Credits (T/P): 3/0</b>                                                                                                                                 | <b>Rumpun MK: Biomedical Instrumentation and Signal Processing</b><br><b>Course Cluster : Biomedical Instrumentation and Signal Processing</b> | Smt: V                                                                  |
| <b>OTORISASI AUTHORIZATION</b>                                                    | <b>Penyusun RA &amp; E Compiler A&amp;EP</b><br><br><b>M. Hilman Fatoni, S.T., M.T.</b>                                                                               | <b>Koordinator RMK Course Cluster Coordinator</b><br><br><b>Dr. Rachmad Setiawan, S.T., M.T.</b>                                               | <b>Ka DEP Head of DEP</b><br><br><b>Dr. Achmad Arifin, S.T., M.Eng.</b> |

| Mg ke / Week (1) | Sub CP-MK / Lesson Learning Outcomes (LLO) (2)                                                                                                                                                                                                                                    | Bentuk Asesmen (Penilaian) Form of Assessment (3)                                                                                                                                                                                                                                                                                         | Bobot / Load (%) (4) |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 1 - 2            | <b>Sub CP-MK 1:</b><br>Mahasiswa mampu memahami, menjelaskan, menghitung dan menganalisa parameter-parameter pada sensor dan transduser<br><br><b>LLO 1 :</b><br><i>Students are able to understand, explain, calculate and analyze the parameters in sensors and transducers</i> | <b>Non-tes :</b><br><b>Tugas 1 :</b><br>Analisa dan menghitung parameter-parameter pada sensor (Tugas tertulis)<br><br><b>Tes :</b><br>Soal ETS 1<br><br><b>Non-test :</b><br><b>Task 1 :</b><br><i>Analyzing and calculating sensor's parameters (Written assignment)</i><br><br><b>Test :</b><br><i>Mid-term examination question 1</i> | 7.5                  |
| 3 - 4            | <b>Sub CP-MK 2:</b><br>Mahasiswa mampu memahami dan menjelaskan tahapan                                                                                                                                                                                                           | <b>Non-tes :</b><br><b>Tugas 2</b><br>Perancangan sensor secara umum melalui pendekatan fenomena dan analogi bahan (Tugas tertulis)                                                                                                                                                                                                       | 7.5                  |

| Mg ke / Week (1) | Sub CP-MK / Lesson Learning Outcomes (LLO) (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Bentuk Asesmen (Penilaian) Form of Assessment (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Bobot / Load (%) (4) |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                  | <p>perancangan sensor secara umum melalui pendekatan fenomena dan analogi bahan</p> <p><b>LLO 2 :</b><br/><i>Students are able to understand and explain the stage of sensor design in general through a phenomenon approach and material analogy</i></p>                                                                                                                                                                                                                                                                                                                                        | <p><b>Tes :</b><br/>Soal ETS 2</p> <p><b>Non-test :</b><br/><b>Task 2 :</b><br/><i>Sensor design in general through fenomenal approach and material analogy (Written assignment)</i></p> <p><b>Test :</b><br/><i>Mid-term examination question 2</i></p>                                                                                                                                                                                                                                                         |                      |
| 5 - 6            | <p><b>Sub CP-MK 3:</b><br/>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis resistif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><b>LLO 3 :</b><br/><i>Students are able to understand and explain the principles of resistive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning</i></p> | <p><b>Non-tes :</b><br/><b>Tugas 3:</b><br/>Mengenai prinsip sensor berbasis resistif, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal ETS 3</p> <p><b>Non-test :</b><br/><b>Task 3 :</b><br/><i>About resistive-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/><i>Mid-term examination question 3</i></p> | 7.5                  |

| Mg ke / Week (1) | Sub CP-MK / Lesson Learning Outcomes (LLO) (2)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bentuk Asesmen (Penilaian) Form of Assessment (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Bobot / Load (%) (4) |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                  | <i>from these sensors</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                      |
| 7, 9             | <p><b>Sub CP-MK 4 :</b><br/>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis induktif, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><b>LLO 4 :</b><br/><i>Students are able understand and explain the principles of inductive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p> | <p><b>Non-tes :</b><br/><b>Tugas 4:</b><br/>Mengenai prinsip sensor berbasis induktif, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal ETS 4</p> <p><b>Non-test :</b><br/><b>Task 4 :</b><br/><i>About inductive-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/><i>Mid-term examination question 4</i></p> | 7.5                  |
| 8                | <p><b>Evaluasi Tengah Semester</b></p> <p><b>Mid Exam</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p><b>Tes:</b><br/>Ujian Tulis/Ujian Daring</p> <p><b>Test:</b><br/><i>Writing Exams / Online Exams</i></p>                                                                                                                                                                                                                                                                                                                                                                                                      | 20                   |
| 10-11            | <p><b>Sub CP-MK 5:</b><br/>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis kapasitif, macam-macamnya, aplikasinya secara</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <p><b>Non-tes :</b><br/><b>Tugas 5:</b><br/>Mengenai prinsip sensor berbasis kapasitif, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal EAS 1</p>                                                                                                                                                                                                                                                                      | 7.5                  |

| Mg ke / Week (1) | Sub CP-MK / Lesson Learning Outcomes (LLO) (2)                                                                                                                                                                                                                                                                                                                                                                                                                       | Bentuk Asesmen (Penilaian) Form of Assessment (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Bobot / Load (%) (4) |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                  | <p>umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><b>LLO 5 :</b><br/> <i>Students are able understand and explain the principles of capacitive-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p> | <p><b>Non-test :</b><br/> <b>Task 5 :</b><br/> <i>About capacitive-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/> <i>Final examination question 1</i></p>                                                                                                                                                                                                                                           |                      |
| 12-13            | <p><b>Sub CP-MK 6 :</b><br/> Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis optikal, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><b>LLO 6 :</b><br/> <i>Students are able to undertand and explain the principles</i></p>                                                                   | <p><b>Non-tes :</b><br/> <b>Tugas 6:</b><br/> Mengenai prinsip sensor berbasis optikal, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b><br/> Soal EAS 2</p> <p><b>Non-test :</b><br/> <b>Task 5 :</b><br/> <i>About optical-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/> <i>Final examination question 2</i></p> | 7.5                  |

| Mg ke / Week (1)             | Sub CP-MK / Lesson Learning Outcomes (LLO) (2)                                                                                                                                                                                                                                                                                                                                                                                                                          | Bentuk Asesmen (Penilaian) Form of Assessment (3)                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Bobot / Load (%) (4) |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                              | <p><i>of optical-based sensors, their types, their general applications and specifically in medical applications and also are able to design, analyze and realize a circuit of signal conditioning from these sensors</i></p>                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                      |
| 13-15                        | <p><b>Sub CP-MK 7 :</b><br/>Mahasiswa mampu memahami dan menjelaskan tentang prinsip sensor berbasis akustik, macam-macamnya, aplikasinya secara umum dan khususnya dalam aplikasi medis, serta mampu merancang, menganalisa dan merealisasikan rangkaian pengkondisi sinyal dari sensor tersebut</p> <p><b>LLO 7 :</b><br/><i>Students are able to undertand and explain the principles of acoustic-based sensors, their types, their general applications and</i></p> | <p><b>Non-tes :</b><br/><b>Tugas 7:</b><br/>Mengenai prinsip sensor berbasis akustik, macam-macamnya, rangkaian pengkondisi sinyal dari sensor dan aplikasinya dalam bidang medis (Tugas tertulis)</p> <p><b>Tes :</b><br/>Soal EAS 3</p> <p><b>Non-test :</b><br/><b>Task 5 :</b><br/><i>About acoustic-based sensor principles, its types, signal conditioning circuit, and its application in biomedical field (Written assignment)</i></p> <p><b>Test :</b><br/><i>Final examination question 3</i></p> | 7.5                  |
| 16                           | <p><b>Evaluasi Akhir</b></p> <p><b>Final Exam</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                   | <p><b>Tes:</b><br/>Ujian Tulis/Ujian Daring</p> <p><b>Test:</b><br/><i>Writing Exams / Online Exams</i></p>                                                                                                                                                                                                                                                                                                                                                                                                 | 27.5                 |
| <b>Total bobot penilaian</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>100%</b>          |

**Indikator Pencapaian CPL Pada MK / Indicator of PLO achievement charged to the course**

| CPL yang dibebankan pada MK / PLO charged to the course | CPMK / Courses Learning Outcome (CLO) | Minggu ke / Week      | Bentuk Asesmen / Form of Assessment | Bobot / Load (%) |
|---------------------------------------------------------|---------------------------------------|-----------------------|-------------------------------------|------------------|
| CPL-01 / PLO-01                                         | CPMK 2 / CLO 2                        | Week 3                | Task 2                              | 7.5              |
|                                                         |                                       | Week 8                | Mid Exam Question 2                 | 5                |
| CPL-02 / PLO-02                                         | CPMK 1 / CLO 1                        | Week 1                | Task 1                              | 7.5              |
|                                                         |                                       | Week 8                | Mid Exam Question 1                 | 5                |
| CPL-05 / PLO-05                                         | CPMK 3 / CLO 3                        | Week 5                | Task 3                              | 7.5              |
|                                                         |                                       | Week 8                | Mid Exam Question 3                 | 5                |
|                                                         | CPMK 4 / CLO 4                        | Week 7                | Task 4                              | 7.5              |
|                                                         |                                       | Week 8                | Mid Exam Question 4                 | 5                |
|                                                         |                                       | Week 10               | Task 5                              | 7.5              |
| CPMK 5 / CLO 5                                          | CPMK 6 / CLO 6                        | Week 16               | Final Exam Question 1               | 7.5              |
|                                                         |                                       | Week 12               | Task 6                              | 7.5              |
|                                                         | Week 16                               | Final Exam Question 2 | 10                                  |                  |
| CPMK 7 / CLO 7                                          | CPMK 7 / CLO 7                        | Week 14               | Task 7                              | 7.5              |
|                                                         |                                       | Week 16               | Final Exam Question 3               | 10               |
|                                                         |                                       |                       |                                     |                  |

| No | Bentuk Asesmen | CPL-01 | CPL-02 | CPL-03 | CPL-04 | CPL-05 | CPL-06 | CPL-07 | CPL-08 | CPL-09 | CPL-10 | CPL-11 | CPL-12 | Total        |
|----|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| 1  | Task 1         |        | 0.075  |        |        |        |        |        |        |        |        |        |        | <b>0.075</b> |
| 2  | Task 2         | 0.075  |        |        |        |        |        |        |        |        |        |        |        | <b>0.075</b> |
| 3  | Task 3         |        |        |        |        | 0.075  |        |        |        |        |        |        |        | <b>0.075</b> |
| 4  | Task 4         |        |        |        |        | 0.075  |        |        |        |        |        |        |        | <b>0.075</b> |
| 5  | Task 5         |        |        |        |        | 0.075  |        |        |        |        |        |        |        | <b>0.075</b> |



| No | Bentuk Asesmen | CPL-01 | CPL-02 | CPL-03 | CPL-04 | CPL-05 | CPL-06 | CPL-07 | CPL-08 | CPL-09 | CPL-10 | CPL-11 | CPL-12 | Total |
|----|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| 6  | Task 6         |        |        |        |        | 0.075  |        |        |        |        |        |        |        | 0.075 |
| 7  | Task 7         |        |        |        |        | 0.075  |        |        |        |        |        |        |        | 0.075 |
| 8  | Mid Exam       | 0.05   | 0.05   |        |        | 0.10   |        |        |        |        |        |        |        | 0.20  |
| 9  | Final Exam     |        |        |        |        | 0.275  |        |        |        |        |        |        |        | 0.275 |
|    | Total          | 0.125  | 0.125  |        |        | 0.75   |        |        |        |        |        |        |        | 1     |