| | Universitas Negeri Surabaya<br>Faculty of Engineering,<br>Mechanical Engineering Undergraduate Study Program | Document Code |
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# SEMESTER LEARNING PLAN

| Courses | CODE | Course Family | Credit Weight | | | SEMESTER | Compilation Date |
|---|---|---|---|---|---|---|---|
| Engineering Materials 2 | 2120102113 | Compulsory Study Program Subjects | T=2 | P=0 | ECTS=3.18 | 2 | July 12, 2022 |

| AUTHORIZATION | SP Developer | Course Cluster Coordinator | Study Program Coordinator |
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| | Novi Sukma Drastiawati | Novi Sukma Drastiawati | Ir. Priyo Heru Adiwibowo, S.T., M.T. |

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| **Learning model** | **Case Studies** | |
| **Program Learning Outcomes (PLO)** | **PLO study program that is charged to the course** | |
| | **PLO-5** | Work independently and in groups |
| | **PLO-11** | Design and development of solutions that take into account the environment and sustainability |
| | **PLO-14** | Science and engineering knowledge |
| | **Program Objectives (PO)** | |
| | **PO - 1** | Ability to Identify specific facts about mathematics, science, and engineering that are needed for a particular situation (What knowledge is needed) b. Able to change real world situations into models that are appropriate to related courses c. Able to demonstrate appropriate use of specific facts of mathematics, science, and engineering to elicit performance behavior given specific input. |
| | **PO - 2** | Able to obtain data about appropriate variables in the field of Mechanical Engineering. b. Able to compare experimental data and results with appropriate theoretical models. c. Be able to explain observed differences between models and experiments. |
| | **PO - 3** | a Able to formulate problems (identify |
| | **PLO-PO Matrix** | |

| P.O | PLO-5 | PLO-11 | PLO-14 |
|---|---|---|---|
| PO-1 | | | |
| PO-2 | | | |
| PO-3 | | | |

**PO Matrix at the end of each learning stage (Sub-PO)**

| P.O | Week | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| PO-1 | | | | | | | | | | | | | | | | |
| PO-2 | | | | | | | | | | | | | | | | |
| PO-3 | | | | | | | | | | | | | | | | |

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| **Short Course Description** | This course discusses mechanical strength in ceramics, polymers and composites, heat treatment processes for non-ferrous steel and non-metallic materials, standardization of non-ferrous steel and non-metallic materials, and case-based learning (case study). | |
| **References** | **Main :** | |

1. [1] Suherman, W. 1999. Ilmu Logam 1. Penerbit ITS: Surabaya
2. [2] Suherman, W. 1999. Ilmu Logam I1. Penerbit ITS: Surabaya
3. [3] Callister, William D. 2003. Material Science and Engineering An Introduction. Sixth Edition. Jhon Wiley & Sons, Inc: USA
4. [4] Smith, William F. Hashemi, Javad. 2006. Foundations of Material Science and Engineering. Fourth Edition. Mc-Graw-Hill Companies, Inc: New York
5. [5] Smith, William F. 1993. Structure and Properties of Engineering Alloy. Second Edition. Mc-Graw-Hill Companies, Inc: New York
6. [6] Dieter, G.E, Mechanical Metallurgy, Mc-Graw Hill, 1988

**Supporters:**

1. [7] Van Vlack, Djaprie, S., Ilmu dan Teknologi Bahan, Edisi IV, Erlangga, Jakarta
2. [8] J.F. Shackelford, Introduction to material Science for engineers, 3rd Ed, Macmillan, 1992

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| **Supporting lecturer** | Mochamad Arif Irfa'i, S.Pd., M.T.<br>Tri Hartutuk Ningsih, S.T., M.T.<br>Novi Sukma Drastiawati, S.T., M.Eng.<br>Hanna Zakiyya, S.T., M.T. |

| Week- | Final abilities of each learning stage (Sub-PO) | Evaluation | | Help Learning, Learning methods, Student Assignments, [ Estimated time] | | Learning materials [ References ] | Assessment Weight (%) |
|---|---|---|---|---|---|---|---|
| | | Indicator | Criteria & Form | Offline ( *offline* ) | Online ( *online* ) | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1 | Describe grain boundary strengthening, solid solution, strain hardening, and precipitation strengthening) | 1. Students are able to describe grain boundary strengthening, solid solution, strain hardening, and precipitation strengthening<br>2. Students are able to explain grain boundary strengthening, solid solutions, strain hardening, precipitation strengthening<br>3. Students are able to describe grain boundary strengthening, solid solution, strain hardening, precipitation strengthening | **Criteria:**<br>1. According to the Engineering Rubric: Participation, Written test, (Quiz-1)<br>2. Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities, Tests | Lectures, discussions and questions and answers<br>2 X 50 | | **Material:** Explains the 4 metal strengthening mechanisms along with their pictures. Depiction of strain hardening. Depiction of precipitation strengthening. Depiction of grain boundary strengthening.<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material: Explaining the mechanism of metal strengthening along with pictures** . Describing strain hardening **.** *Sixth Edition. John Wiley & Sons, Inc: USA* | 1% |

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| **2** | Describe grain boundary strengthening, solid solution, strain hardening, and precipitation strengthening) | 1. Students are able to describe grain boundary strengthening, solid solution, strain hardening, and precipitation strengthening<br>2. Students are able to explain grain boundary strengthening, solid solutions, strain hardening, precipitation strengthening<br>3. Students are able to describe grain boundary strengthening, solid solution, strain hardening, precipitation strengthening | **Criteria:**<br>1. According to the Engineering Rubric: Participation, Written test, (Quiz-1)<br>2. Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities, Tests | Lectures, discussions and questions and answers<br>2 X 50 | | **Material:** Explains the 4 metal strengthening mechanisms along with their pictures. Depiction of strain hardening. Depiction of precipitation strengthening. Depiction of grain boundary strengthening.<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material: Explaining the mechanism of metal strengthening along with pictures** . Describing strain hardening **.** *Sixth Edition. John Wiley & Sons, Inc: USA* | 1% |
| **3** | Describe grain boundary strengthening, solid solution, strain hardening, and precipitation strengthening) | 1. Students are able to describe grain boundary strengthening, solid solution, strain hardening, and precipitation strengthening<br>2. Students are able to explain grain boundary strengthening, solid solutions, strain hardening, precipitation strengthening<br>3. Students are able to describe grain boundary strengthening, solid solution, strain hardening, precipitation strengthening | **Criteria:**<br>1. According to the Engineering Rubric: Participation, Written test, (Quiz-1)<br>2. Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities, Tests | Lectures, discussions and questions and answers<br>2 X 50 | | **Material:** Explains the 4 metal strengthening mechanisms along with their pictures. Depiction of strain hardening. Depiction of precipitation strengthening. Depiction of grain boundary strengthening.<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material: Explaining the mechanism of metal strengthening along with pictures** . Describing strain hardening **.** *Sixth Edition. John Wiley & Sons, Inc: USA* | 2% |

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| **4** | Describe aluminum and its alloys and copper and its alloys | 1. Able to describe aluminum and its alloys and copper and its alloys<br>2. Able to explain aluminum and its alloys and copper and its alloys<br>3. Able to describe the microstructure of aluminum alloys and copper alloys | **Criteria:**<br>Participation and assignments Grade criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** :<br>Participatory Activities, Portfolio Assessment, Tests | Offline<br>2x 50 | | **Material:**<br>Mention at least 3 aluminum and its alloys<br>Mention at least 3 copper and its alloys<br>Give examples of the use of aluminum alloys and copper alloys for industry<br>**References:**<br>*[4] Smith, William F. Hashemi, Javad. 2006. Foundations of Materials Science and Engineering. Fourth Edition. Mc-Graw-Hill Companies, Inc: New York*<br><br>**Material:**<br>Mention at least 3 aluminum and its alloys<br>Mention at least 3 copper and its alloys<br>Exemplify the use of aluminum alloys and copper alloys for industry<br>**References:**<br>*[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988*<br><br>**Material:**<br>Mention at least 3 aluminum and its alloys<br>Mention at least 3 copper and its alloys<br>Give examples of the use of aluminum alloys and copper alloys for the industrial world<br>**References:**<br>*[2] Suherman, W. 1999. Metal Science I1. ITS Publisher: Surabaya* | 2% |

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| **5** | Describe aluminum and its alloys and copper and its alloys | 1. Able to describe aluminum and its alloys and copper and its alloys<br>2. Able to explain aluminum and its alloys and copper and its alloys<br>3. Able to describe the microstructure of aluminum alloys and copper alloys | **Criteria:**<br>Participation and assignments Grade criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** :<br>Participatory Activities, Portfolio Assessment, Tests | Offline<br>2 x 50 | | **Material:**<br>Mention at least 3 aluminum and its alloys<br>Mention at least 3 copper and its alloys<br>Give examples of the use of aluminum alloys and copper alloys for industry<br>**References:**<br>*[4] Smith, William F. Hashemi, Javad. 2006. Foundations of Materials Science and Engineering. Fourth Edition. Mc-Graw-Hill Companies, Inc: New York*<br><br>**Material:**<br>Mention at least 3 aluminum and its alloys<br>Mention at least 3 copper and its alloys<br>Exemplify the use of aluminum alloys and copper alloys for industry<br>**References:**<br>*[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988*<br><br>**Material:**<br>Mention at least 3 aluminum and its alloys<br>Mention at least 3 copper and its alloys<br>Give examples of the use of aluminum alloys and copper alloys for the industrial world<br>**References:**<br>*[2] Suherman, W. 1999. Metal Science I1. ITS Publisher: Surabaya* | 2% |
| **6** | Describe magnesium and its alloys, nickel and its alloys | 1. a. Able to describe magnesium and its alloys, nickel and its alloys<br>2. b. Explains magnesium and its alloys, nickel and its alloys<br>3. c. Describe the microstructure of magnesium alloys, nickel alloys | **Criteria:**<br>According to the Rubric. Technique: Participation, Written test, (Quiz-3). Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** :<br>Participatory Activities, Portfolio Assessment, Tests | Lectures, discussions, exercises and questions and answers<br>2X 50 | | **Material:**<br>Mention at least 3 examples of magnesium alloys Mention at least 3 examples of nickel alloys<br>Give examples of the use of magnesium and nickel alloys<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya* | 2% |

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| **7** | Describe magnesium and its alloys, nickel and its alloys | 1.a. Able to describe magnesium and its alloys, nickel and its alloys<br>2.b. Explains magnesium and its alloys, nickel and its alloys<br>3.c. Describe the microstructure of magnesium alloys, nickel alloys | **Criteria:**<br>According to the Rubric. Technique: Participation, Written test, (Quiz-3). Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** :<br>Participatory Activities, Portfolio Assessment, Tests | Lectures, discussions, exercises and questions and answers<br>2X 50 | | **Material:** Mention at least 3 examples of magnesium alloys Mention at least 3 examples of nickel alloys Give examples of the use of magnesium and nickel alloys<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya* | 3% |
| **8** | Sub Exam | UTS | **Criteria:**<br>according to the rubric<br><br>**Form of Assessment** :<br>Participatory Activities | Doing the 2 x 50 test | | **Material:** UTS<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material:** UTS<br>**References:**<br>*[2] Suherman, W. 1999. Metal Science I1. ITS Publisher: Surabaya*<br><br>**Material:** UTS<br>**References:**<br>*[3] Callister, William D. 2003. Materials Science and Engineering An Introduction. Sixth Edition. John Wiley & Sons, Inc: USA*<br><br>**Material:** UTS<br>**References:**<br>*[5] Smith, William F. 1993. Structure and Properties of Engineering Alloy. Second Edition. Mc-Graw-Hill Companies, Inc: New York*<br><br>**Material:** UTS<br>**References:**<br>*[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988*<br><br>**Material:** UTS<br>**References:**<br>*[7] Van Vlack, Djaprie, S., Materials Science and Technology, Edition IV, Erlangga, Jakarta* | 20% |

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| **9** | Describe titanium and its alloys | 1.a. Able to describe titanium and<br>2.b. Able to explain titanium and its alloys<br>3.c. Able to describe the microstructure of titanium alloys | **Criteria:**<br>Technique: Participation, Written test, (Quiz-4). Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities | Offline<br>2 x 50 | | **Material:**<br>Mentions 3 examples of titanium alloys. Examples of the use of titanium alloys in the industrial world.<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya* | 2% |
| **10** | Calculating the mechanical strength of ceramics | 1.a. Able to calculate the mechanical strength of ceramics<br>2.b. Able to explain the results of mechanical strength calculations for ceramics<br>3.c. Able to differentiate test results after carrying out theoretical calculations with the results of trial data in a study (article) | **Criteria:**<br>According to the Rubric.<br><br>**Form of Assessment** :<br>Participatory Activities | Lectures, discussions, questions and answers and<br>2 X 50 exercises | | **Material:**<br>Calculating the hardness value of ceramic materials Calculating the impact strength value of ceramics<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya* | 5% |
| **11** | Perform mechanical strength calculations on polymers and composites | 1.a. Able to calculate mechanical strength in polymer ceramics and composites<br>2.b. Able to explain the results of mechanical strength calculations for polymers and composites<br>3.cc Able to differentiate test results after carrying out theoretical calculations with the results of trial data in a study | **Criteria:**<br>According to the Rubric. Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities | Lectures, discussions, questions and answers, and<br>2 X 50 exercises | | **Material:**<br>Calculating tensile strength values in polymers Calculating tensile strength values in composites<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya* | 5% |

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| **12** | Perform mechanical strength calculations on polymers and composites | 1.a. Able to calculate mechanical strength in polymer ceramics and composites<br>2.b. Able to explain the results of mechanical strength calculations for polymers and composites<br>3.cc Able to differentiate test results after carrying out theoretical calculations with the results of trial data in a study | **Criteria:**<br>According to the Rubric. Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities | Lectures, discussions, questions and answers, and<br>2 X 50 exercises | | **Material:**<br>Calculating tensile strength values in polymers<br>Calculating tensile strength values in composites<br>**References:**<br>*[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya* | 5% |
| **13** | Practical heat treatment on steel<br>Laboratory practical heat treatment on metal | 1.Able to classify heat treatments on metals Able to describe the heating scheme for each treatment Able to explain the stages of metal formation<br>2.Carrying out hardness testing on steel materials after the heat treatment process on non-ferrous metals<br>3.Able to present practical results and analyze practical results | **Criteria:**<br>According to the Rubric. Technique: Participation, Written test, (Quiz-3). Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** :<br>Participatory Activities, Portfolio Assessment, Practice / Performance | Lectures, discussions, questions and answers, and<br>2 X 50 exercises | | **Material:**<br>Practical<br>**Literature:** *[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material:**<br>Practical<br>**Library:** *[8] JF Shackelford, Introduction to materials Science for engineers, 3rd Ed, Macmillan, 1992*<br><br>**Material:**<br>Practical<br>**References:**<br>*[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988* | 5% |

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| **14** | Practical heat treatment on steel Laboratory practical heat treatment on metal | 1. Able to classify heat treatments on metals Able to describe the heating scheme for each treatment Able to explain the stages of metal formation<br>2. Carrying out hardness testing on steel materials after the heat treatment process on non-ferrous metals<br>3. Able to present practical results and analyze practical results | **Criteria:** According to the Rubric. Technique: Participation, Written test, (Quiz-3). Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practice / Performance | Lectures, discussions, questions and answers, and 2 X 50 exercises | | **Material:** Practical **Literature:** *[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material:** Practical **Library:** *[8] JF Shackelford, Introduction to materials Science for engineers, 3rd Ed, Macmillan, 1992*<br><br>**Material:** Practical **References:** *[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988* | 7% |
| **15** | Practical heat treatment on steel Laboratory practical heat treatment on metal | 1. Able to classify heat treatments on metals Able to describe the heating scheme for each treatment Able to explain the stages of metal formation<br>2. Carrying out hardness testing on steel materials after the heat treatment process on non-ferrous metals<br>3. Able to present practical results and analyze practical results | **Criteria:** According to the Rubric. Technique: Participation, Written test, (Quiz-3). Score criteria: Special: 90 to 100; Very good: 76 to 89; Average: 56 to 75; Below average: 0 to 55<br><br>**Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practice / Performance | Lectures, discussions, questions and answers, and 2 X 50 exercises | | **Material:** Practical **Literature:** *[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material:** Practical **Library:** *[8] JF Shackelford, Introduction to materials Science for engineers, 3rd Ed, Macmillan, 1992*<br><br>**Material:** Practical **References:** *[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988* | 7% |

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| **16** | UAS | | **Criteria:**<br>Score criteria:<br>Special: 90 to 100;<br>Very good: 76 to 89;<br>Average: 56 to 75;<br>Below average: 0 to 55<br><br>**Form of Assessment** :<br>Participatory Activities, Tests | UAS<br>2 X 50 | | **Material:** UAS<br>**Reference:** *[1] Suherman, W. 1999. Metal Science 1. ITS Publisher: Surabaya*<br><br>**Material:** UAS<br>**References:** *[3] Callister, William D. 2003. Materials Science and Engineering An Introduction. Sixth Edition. John Wiley & Sons, Inc: USA*<br><br>**Material:** UAS<br>**References:** *[5] Smith, William F. 1993. Structure and Properties of Engineering Alloy. Second Edition. Mc-Graw-Hill Companies, Inc: New York*<br><br>**Material:** UAS<br>**References:** *[6] Dieter, GE, Mechanical Metallurgy, Mc-Graw Hill, 1988*<br><br>**Material:** UAS<br>**References:** *[7] Van Vlack, Djaprie, S., Materials Science and Technology, Edition IV, Erlangga, Jakarta* | 30% |

**Evaluation Percentage Recap: Case Study**

| No | Evaluation | Percentage |
|---|---|---|
| 1. | Participatory Activities | 63.34% |
| 2. | Portfolio Assessment | 9.34% |
| 3. | Practice / Performance | 6.33% |
| 4. | Test | 20.01% |
| | | 99.02% |

**Notes**

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.

8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.