| | Universitas Negeri Surabaya<br>Faculty of Mathematics and Natural Sciences<br>Undergraduate Physics Study Program | Document Code |
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# SEMESTER LEARNING PLAN

| Courses | CODE | Course Family | Credit Weight | | | SEMESTER | Compilation Date |
|---|---|---|---|---|---|---|---|
| Solid State Physics | 4520103082 | Compulsory Study Program Subjects | T=3 | P=0 | ECTS=4.77 | 6 | March 21, 2021 |

| AUTHORIZATION | SP Developer | Course Cluster Coordinator | Study Program Coordinator |
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| | Prof. Dr. Munasir, S.Si., M.Si. & Dr. Evi Suaebah, M.Si., M.Eng. | Prof. Dr. Munasir, S.Si., M.Si. | Prof. Dr. Munasir, S.Si., M.Si. |

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| **Learning model** | **Case Studies** | |
| **Program Learning Outcomes (PLO)** | **PLO study program that is charged to the course** | |
| | **PLO-7** | Communicate their ideas and/or research results in academic writing and speaking effectively. |
| | **PLO-12** | Have the ability to improve their knowledge and be able to continue their studies to a higher level. |
| | **Program Objectives (PO)** | |
| | **PO - 1** | Review and present the results of the study of Solid State Physics material which includes: crystal structure of solid materials, crystal bonds; solid material structure test methods (XRD, ND, ED, etc.); phonon vibrations (gel. optic & acoustic) and thermal properties of solid materials; electrical properties of solid materials: (conductors-Drude's theory & Ohm's law, semiconductors-holes/electrons and superconductors-electron pairs) and energy bands; semiconductor (Si-crystalline, Si-amorphous, organic); optical properties of solid materials; magnetic properties of solid materials; dielectric materials, capacitors and supercapacitors; Superconductivity and superconducting materials; from various references. |
| | **PO - 2** | Produce a paper on the results of a Solid State Physics study and present it. |
| | **PO - 3** | Produce project work related to solid state physics material and present it |
| | **PLO-PO Matrix** | |

| P.O | PLO-7 | PLO-12 |
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| 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** | Examining Solid State Physics material, which includes: Crystal Structure; X Ray Diffraction, Neutron Diffraction, Electron Diffraction and (XRF, SEM, TEM, AFM); Crystal Bond; Grille Vibration; Einstein Model; Debye Model, Band Structure and Electrical Properties of Materials: Semiconductors, insulators and metals, The concept of effective mass; Pure Semiconductors and Impurities: Donors and Acceptors, Fermi level, Ef, Carrier concentration equations, Donors and acceptors both present; pn junction, pn Junction Diode; Electrical Conductance, Hall Effect; Light Emitting Diode; Paramagnetism, Diamagnetism, Ferromagnetism, Superconductors, Dielectrics, Supercapacitors |

**References**

**Main :**


1. Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.
2. Ashcroft and Mermin . 1976. Solid State Physics . Sauders College, Philadelphia.
3. Ali Omar, M . 1975. Elementary Solid State Physics: Principle and Applications . Addison Wesley Publication. Comp. USA.
4. Ali Omar, M . 1977. Fundamental of Solid State Physics . Addison Wesley Publication. Comp.USA.
5. Christman . 1989. Introduction to Solid State Physics . John Wiley & Sons, USA.
6. H.M. Rosenberg . 1987. The Solid State Physics Third Edition . Oxford Science Publication, USA.
7. M. S. Dresselhaus, 2001, Solid state Physics, MIT, USA.


**Supporters:**

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| | 1. Sze, S.M. 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.<br>2. Reka Rio, S., dan Iida, Masamori1982. Fisika dan Teknologi Semikonduktor. Jakarta: P.T. Pradnya Paramita.<br>3. Anderson, J.C., Leaver. K.D., Rawlings, R.D., and Alexander, J.M. 1990. Materials Science, 4th Ed. London: Chapman & Hall. |
| **Supporting lecturer** | Prof. Dr. Munasir, S.Si., M.Si.<br>Dr. Fitriana, S.Si. |

| **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** | Able to analyze the crystal structure of solid materials and present them | Describe the task given | **Criteria:**<br>Full marks will be given if all questions can be answered correctly & satisfactorily<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers,<br>3 X 50 | Presentations, discussions and questions and answers,<br>3 x 50 | **Material:** Crystal structure of solid materials<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 2% |
| **2** | Able to analyze solid material structure analysis material (XRD, XRF, ND, etc.) and present | 1. Producing a paper on the results of a study of Solid State Physics – Crystal Structure;<br>2. Able to present a paper on the results of a study of Solid State Physics - Crystal Structure.<br>3. Determine the number of nearby atoms, crystal density (r): linear density, planar density, crystal density factor (APF) | **Criteria:**<br>Full marks will be given if all questions can be answered correctly & satisfactorily<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** Crystal structure of solid materials<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** crystal lattice, Bravais lattice, crystal structure analysis, simple crystal structure, field.<br>**Reference:**<br>*Ashcroft and Mermin. 1976. Solid State Physics. Sauders College, Philadelphia.* | 2% |
| **3** | Able to analyze Crystal Bond material and present | 1. Producing Papers on the results of Solid State Physics studies - Analysis of Diffraction Data using X-Ray Diffraction, Neutron Diffraction, Electron Diffraction;<br>2. Able to present a paper on the results of a Solid State Physics study - Analysis of Diffraction Data using X-Ray Diffraction, Neutron Diffraction, Electron Diffraction; | **Criteria:**<br>Full marks will be given if all questions can be answered correctly & satisfactorily<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** X-ray diffraction analysis<br>**References:**<br>*Kittel, Charles. 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** Electron diffraction<br>**Reader:**<br>*Christman . 1989. Introduction to Solid State Physics. John Wiley & Sons, USA.*<br><br>**Material:** Neutron diffraction<br>**References:**<br>*Anderson, JC, Leaver. KD, Rawlings, RD, and Alexander, JM 1990. Materials Science, 4th Ed. London: Chapman & Hall.* | 3% |

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| **4** | Able to produce and present papers on the results of studies on Solid State Physics - Crystal Bonds. | 1. Producing papers on the results of studies on Solid State Physics – Crystal Bonds;<br>2. Able to present a paper on the results of a study of Solid State Physics - Crystal Bonds. | **Criteria:**<br>Full marks will be given if all questions can be answered correctly & satisfactorily<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** Crystal bonds of solid materials<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 3% |
| **5** | Able to produce and present papers on the results of studies on Solid State Physics – Lattice Vibrations | Producing a paper on the results of a study of Solid State Physics – Lattice Vibrations; Able to present a paper on the results of a study of Solid State Physics - Lattice Vibrations. | **Criteria:**<br>Grades are given if all tasks have been completed<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3x50 | **Material:** Lattice vibrations<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 3% |
| **6** | Able to produce and present papers on the results of Solid State Physics studies - Einstein Model and Debye Model. | 1. Producing papers on the results of studies on Solid State Physics – Einstein‘s Model and Debye‘s Model; Able to present papers on the results of solid state physics studies - Einstein‘s model and Debye‘s model.<br>2. Able to present solid state physics studies related to the Einstein and Debye models | **Criteria:**<br>Grades are given if all assignments have been completed<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x50 | **Material:** Heat capacity according to: Einstein Model and Debye Model<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 3% |
| **7** | Able to produce and present papers on the results of studies on Solid State Physics - Band Structure and Electrical Properties of Materials: Semiconductors, insulators and metals, The concept of effective mass. | Produce papers on the results of studies on Solid State Physics – Band Structure and Electrical Properties of Materials: Semiconductors, insulators and metals, The concept of effective mass; Able to present a paper on the results of a study of Solid State Physics - Crystal Structure. | **Criteria:**<br>Full marks will be given if all questions can be answered correctly & satisfactorily<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** Intrinsic, extrinsic semiconductors (donor acceptor)<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Material:** Silicon semiconductor technology<br>**References:**<br>*Reka Rio, S., and Iida, Masamori 1982. Semiconductor Physics and Technology. Jakarta: PT Pradnya Paramita.* | 3% |

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| **8** | A combination of meetings 1-7 | A combination of meetings 1-7 | **Criteria:**<br>Full marks will be given if the questions have been completed completely and correctly<br><br>**Form of Assessment** :<br>Portfolio Assessment | Doing 3 X 50 UTS (written test) questions | Doing 3 X 50 UTS (written test) questions | **Material:** Crystal structure of solid materials<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** X-ray diffraction analysis<br>**References:**<br>*Kittel, Charles. 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** Crystal bonds of solid materials<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** Intrinsic, extrinsic semiconductors (donor acceptor)<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Material:** Heat capacity according to: Einstein Model and Debye Model<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 30% |
| **9** | Able to produce and present papers on the results of Solid State Physics studies - Pure and Impurity Semiconductors: Donors and Acceptors, Fermi level, Ef, Carrier concentration equations, Donors and acceptors both present, | 1. Produce a paper on the results of a study on Solid State Physics - Pure and Impure Semiconductors: Donors and Acceptors, Fermi level, Ef, Carrier concentration equations, Donors and acceptors both present;<br>2. Able to present a paper on the results of a Solid State Physics study - Pure and Impure Semiconductors: Donors and Acceptors, Fermi level, Ef, Carrier concentration equations, Donors and acceptors both present. | **Criteria:**<br>Full marks will be given if the answers to all questions are correct<br><br>**Form of Assessment** :<br>Participatory Activities | Presentations, discussions and questions and answers 3 X 50 | Presentations, discussions and questions and answers 3 x 50 | **Material:** Fermi level, and PN connection<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Material:** Donor-acceptor level<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.* | 3% |

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| **10** | Able to produce and present papers on the results of studies on Solid State Physics - pn junctions, pn junction diodes. | 1. Produce papers on the results of studies on Solid State Physics – pn junctions, pn junction diodes;<br>2. Able to present a paper on the results of a study on Solid State Physics - pn junction, pn junction diode. | **Criteria:**<br>Full marks will be given if all the answers to the questions are correct<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** PN connections in semiconductors<br>**References:**<br>*Reka Rio, S., and Iida, Masamori 1982. Semiconductor Physics and Technology. Jakarta: PT Pradnya Paramita.*<br><br>**Material:** PN junction diode<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Material:** Diode laser<br>**Reference:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.* | 3% |
| **11** | Able to produce and present papers on the results of studies on Solid State Physics - Electrical Conductance, Hall Effect. | 1. Produce papers on the results of studies on Solid State Physics – electrical properties and optical properties;<br>2. Able to present a paper on the results of a study on Solid State Physics - Electrical Conductance, Hall Effect. | **Criteria:**<br>Full marks will be given if the questions have been completed completely and correctly<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** Hall Effect<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Material:** Hall Effect<br>**References:**<br>*Reka Rio, S., and Iida, Masamori 1982. Semiconductor Physics and Technology. Jakarta: PT Pradnya Paramita.* | 3% |
| **12** | Able to produce and present papers on the results of studies on Solid State Physics - Light Emitting Diodes. | 1. Producing a paper on the results of a study of Solid State Physics - Light Emitting Diodes;<br>2. Able to present a paper on the results of a study on Solid State Physics - Light Emitting Diodes. | **Criteria:**<br>Full marks will be given if the questions have been completed completely and correctly<br><br>**Form of Assessment** : Participatory Activities | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** Intrinsic, extrinsic semiconductors (donor acceptor)<br>**References:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 3% |

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| **13** | Able to produce and present papers on the results of Solid State Physics studies – Paramagnetism, Diamagnetism, Ferromagnetism. | 1. Producing Papers on the results of studies on Solid State Physics – Paramagnetism, Diamagnetism,<br>2. Able to present papers on the results of studies on Solid State Physics - Paramagnetism, Diamagnetism, | **Criteria:**<br>Full marks will be given if the questions have been completed completely and correctly<br><br>**Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Matter:** Magnetic properties of solid materials: Paramagnetism, Diamagnetism, Ferromagnetism.<br>**Reference:** *Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Matter:** Magnetic properties of solid materials: Paramagnetism, Diamagnetism, Ferromagnetism.<br>**References:** *Ali Omar, M. 1975. Elementary Solid State Physics: Principles and Applications. Addison Wesley Publications. Comp. USA.*<br><br>**Matter:** Magnetic properties of solid materials: Paramagnetism, Diamagnetism, Ferromagnetism.<br>**Bibliography:** *Ashcroft and Mermin . 1976. Solid State Physics. Sauders College, Philadelphia.* | 3% |
| **14** | Able to produce and present papers on the results of studies on Solid State Physics - Superconductors | 1. Produce papers on the results of FZP studies: Paramagnetism, Ferromagnetism;<br>2. Able to present papers on the results of studies on Solid State Physics - Paramagnetism, Ferromagnetism. | **Criteria:**<br>Full marks will be given if the questions have been completed completely and correctly<br><br>**Form of Assessment** : Participatory Activities | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x50 | **Material:** Superconductivity and superconductors<br>**Reference:** *Christman . 1989. Introduction to Solid State Physics. John Wiley & Sons, USA.*<br><br>**Material:** Superconductors<br>**Reference:** *Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 3% |
| **15** | Able to produce and present papers on the results of studies on Solid State Physics - Dielectric Materials and supercapacitors | 1. Producing papers on the results of studies on Solid State Physics - Superconductors;<br>2. Able to present papers on the results of studies on Solid State Physics - Superconductors. | **Criteria:**<br>Full marks will be given if the questions have been completed completely and correctly<br><br>**Form of Assessment** : Participatory Activities | Presentations, discussions and questions and answers.<br>3 X 50 | Presentations, discussions and questions and answers.<br>3 x 50 | **Material:** Dielectric Materials and supercapacitors<br>**Reference:** *Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 3% |

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| **16** | Combined 9-15 meetings | Able to do questions correctly | **Criteria:**<br>The answer must be correct according to the concept being asked<br><br>**Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Portfolio Assessment | UAS: spell 3 x 50 test questions | | **Material:** Heat capacity according to: Einstein Model and Debye Model<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** Intrinsic, extrinsic semiconductors (donor acceptor)<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Material:** PN connection<br>**Bibliography:**<br>*Reka Rio, S., and Iida, Masamori 1982. Semiconductor Physics and Technology. Jakarta: PT Pradnya Paramita.*<br><br>**Material:** Laser diode<br>**References:**<br>*Sze, SM 1985. Semiconductor Devices (Physics and Technology). New York: John Wiley & Sons: Lattice Press.*<br><br>**Matter:** magnetic properties of solid materials: paramagnetic, diamagnetic and ferromagnetic<br>**Bibliography:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** Dielectric materials and supercapacitors<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.*<br><br>**Material:** Superconductors<br>**Reference:**<br>*Kittel, Charles . 1996 . Introduction to Solid State Physics 7th. John Wiley & Sons, New York.* | 30% |

**Evaluation Percentage Recap: Case Study**

| No | Evaluation | Percentage |
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| 1. | Participatory Activities | 36% |
| 2. | Project Results Assessment / Product Assessment | 24% |
| 3. | Portfolio Assessment | 40% |
| | | 100% |

**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.