# Subject Description Form

| | |
|---|---|
| **Subject Code** | AP40005 |
| **Subject Title** | Optoelectronic Packaging and Reliability |
| **Credit Value** | 3 |
| **Level** | 4 |
| **Pre-requisite/ Co-requisite/ Exclusion** | Nil |
| **Objectives** | The aim of this subject is to provide students with an understanding of reliability requirements, testing techniques, packaging and assembly processes of optoelectronic materials, devices and systems. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br><br>(a) explain basic reliability physics and engineering of basic devices;<br>(b) apply the fundamentals of optics to describe the laser diode-to-fiber coupling and fiber-to-fiber coupling in optoelectronic packaging;<br>(c) explain the origins and remedial actions of various packaging-related reliability mechanisms;<br>(d) describe the structure, principles of operation, fabrication, possible defects and contaminations related to the reliability and packaging issues of basic optoelectronic devices;<br>(e) explain the principles and limitations of different microscopic/analytical techniques for the device diagnosis before and after the package is opened;<br>(f) perform optical, electrical, thermal, mechanical and environmental analysis on the reliability and packaging of lasers, optical fibers and optical components;<br>(g) analyze high-power light-emitting diodes (LEDs) packaging as well as the requirements and approaches to determine LEDs performance and reliability; and<br>(h) describe design type, package requirements, process and assembly conditions of various optoelectronic devices and arrays. |
| **Subject Synopsis/ Indicative Syllabus** | **Overview of optoelectronic packaging**: development flow of devices fabrication; packaging functions of light sources; optical waveguides and detectors; optoelectronic vs. electronic packaging.<br><br>**Fundamentals of reliability**: mathematical models of the characteristic curve; accelerated testing; time-to-failure modeling; failure analysis.<br><br>**Package-related reliability mechanisms**: corrosion, electromigration; solder fatigue; spiking effect; die attachment failure; stress-voiding; defects and contaminations; electrically-induced damage.<br><br>**Techniques for materials characterization**: materials for optoelectronic packaging; techniques prior to the package opening**;** package opening techniques; microscopic techniques; analytical techniques.<br><br>**Reliability of optoelectronic devices**: reliability testing of lasers and LEDs; microscopic mechanisms of laser damage; contacts and bonding reliability; optical fiber strength; static fatigue of fiber; environmental degradation of optical fiber. |

**Methods for optoelectronic packaging**: thermal; mechanical and electrical design considerations; optical alignment; technologies for optoelectronic packaging.

**Packaging of light sources**: light extraction; encapsulation and protection; laser die bonding; high-power LEDs packaging.

**Packaging of optical waveguide and detectors**: couple laser to fiber**;** pigtail fiber to detector; transceiver packages; optical interconnects.

**Teaching/Learning Methodology**

**Lecture**: The fundamentals of reliability and packaging of various optoelectronic devices will be described. Students are free to request help. Students are encouraged to solve problems and to use their own knowledge to verify their solutions before seeking assistance.

**Tutorial**: A set of problems and group discussion topics will be arranged in the tutorial classes. Students are encouraged to solve problems before having solutions.

**Laboratory**: A set of laboratories/demonstrations will be provided. Students will have the opportunity to apply the fundamental knowledge gained from the lecture into practical materials test and device applications and hence develop a deeper understanding of the subject.

**Assessment Methods in Alignment with Intended Learning Outcomes**

| Specific assessment methods/tasks | % weighting | Intended subject learning outcomes to be assessed (Please tick as appropriate) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | e | f | g | h |
| (1) Continuous assessment | 40 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| (2) Examination | 60 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Total | 100 | | | | | | | | |

Continuous assessment consists of assignments, laboratory reports and mid-term test. The continuous assessment will assess the students' understanding of basic concepts and principles in materials science. Examination will be conducted to make a comprehensive assessment of students' intended learning outcomes as stated above.

**Student Study Effort Expected**

| | |
|---|---|
| Class contact: | |
| • Lecture | 26 h |
| • Tutorial | 6 h |
| • Laboratory | 9 h |
| Other student study effort: | |
| • Self-study | 79 h |
| Total student study effort | 120 h |

**Reading List and**

Robert W. Herrick, Failure Analysis and Reliability of Optoelectronic Devices (2004).

| | |
|---|---|
| **References** | Richard K. Ulrich and William D. Brown, Advanced Electronic Packaging, John Wiley & Sons, Inc. (2006).<br><br>D. Lu, C.P. Wong (eds.), Materials for Advanced Packaging, Springer (2009). |