Subject Description Form

Subject Code	AP30014
Subject Title	Science and Technology of Photovoltaics
Credit Value	3
Level	3
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The objective of this course is to study the operation principles, device structures, fabrication technologies and characterizations of various types of solar cells, and photovoltaic system engineering.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) understand the nature of solar radiation and the energy input to a photovoltaic system; (b) apply the fundamental physics to explain the operation principle of single-junction solar cells, and understand the materials properties and device structures are critical to photovoltaics; (c) identify the technological steps which are used in the manufacture of solar cells; (d) evaluate the performance of photovoltaic devices by using their characteristics, including current-voltage (I-V) and spectral response curves. (e) acknowledge the principles, fabrication and performances of various types of advanced solar cells, including thin-film and tandem cells, dye-sensitized cells, nanostructured cells, organic photovoltaics, and thermo photovoltaic devices. (f) acknowledge solar module, solar photovoltaic system, and power conditioning and control.
Subject Synopsis/ Indicative Syllabus	**Solar radiation and electricity from sun**: energy from the sun; solar spectrum; air mass AM0 and AM1.5; sun simulator; history and status of photovoltaics. **Principles of a p-n junction solar cell**: semiconductor basics; light absorption; I-V characteristics; operation principle; equivalent circuit of solar cell; performance parameters (V_{oc}, I_{sc}, FF, η) and spectral response. **Solar cell design and fabrication**: power loss; limitations on energy conversion; managing light; optimization of Si solar cell design; alternatives to silicon (GaAs, etc.); fabrication process. **Advanced photovoltaic devices**: thin-film and tandem solar cell technologies; dye-sensitized cells; nanostructured cells; organic photovoltaics; and thermo photovoltaic devices. **Photovoltaic modules and system**: solar module and arrays; energy storage systems; DC/DC and DC/AC converters; charge controller; operation of solar photovoltaic system.

<table>
<tr><td>Teaching/Learning Methodology</td><td>Lecture: The concepts, fundamentals and technologies of solar cells will be explained. Delivery of lectures interactively to enable students to participate actively in acquiring knowledge. Students are encouraged to solve problems and to use their own knowledge to verify their solutions.

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

Laboratory: Laboratory/demonstration will be provided. Students will have the opportunity to apply the knowledge gained from the lecture into practical test and applications.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>(1) Continuous assessment</td><td>40</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>(2) Examination</td><td>60</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100</td><td colspan="6"></td></tr>
</table>

Continuous assessment consists of assignments, laboratory reports and mid-term test. The continuous assessment will assess the students' understanding of basic concepts, principles and applications. Examination will be conducted to make a comprehensive assessment of students' intended learning outcomes as stated above.</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>• Lecture</td><td>26 h</td></tr>
<tr><td>• Tutorial</td><td>6 h</td></tr>
<tr><td>• Laboratory</td><td>9 h</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>• Self-study</td><td>79 h</td></tr>
<tr><td>Total student study effort</td><td>120 h</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>P. Jayarama Reddy, "Science and Technology of Photovoltaics", 2nd Edition, CRC Press, (2010).
Martin A. Green, "Third Generation Photovoltaics: Advanced Solar Energy Conversion", SpringerLink e-books, (2006).
Peter Würfel, "Physics of Solar Cells: From Principles to New Concepts", Wiley-VCH (2005).</td></tr>
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