Subject Description Form

Subject Code	AP30009
Subject Title	Laser Principles and Applications
Credit Value	3
Level	3
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The course introduces various lasers, CW, Q-switched, tunable and mode locked lasers with emphasis on working principles, laser design and also laser applications. The course features a natural and logical blend of theory and engineering.
Intended Learning Outcomes	Upon the completion of the subject, students will be able to: (a) describe the operation principles of CW, Q-switched, mode locked, tunable lasers, lineshape broadening, laser rate equations for three level and four level laser systems, the difference between spontaneous and stimulated emission, coherent and incoherent radiation, longitudinal mode and transverse mode; (b) relate the population inversion and optical feedback to laser technology/ implementation; (c) apply the optical ray transfer matrix to determine the stability of a laser resonator; (d) describe the coherent properties and high brightness of laser, and how these laser properties related to their applications, and apply laser selection criteria for selecting suitable laser specific applications; and (e) apply the knowledge of lasers to solve some real life problems.
Subject Synopsis/ Indicative Syllabus	**Laser principles of CW laser**: three level and four level lasers system, wavelength line-shape broadening, coherence of radiation, stimulated emission, laser gain media, laser rate equations, techniques of pumping, laser resonator, longitudinal mode and transverse mode. **Laser principles of pulsed laser**: Q-switched and mode locked lasers. **Study design of various types of laser systems**: ultra-fast lasers, gas discharge lasers, diode pumped solid state lasers, semiconductor lasers, tunable dye lasers. **Laser characterization**: beam quality, divergence, pulse width, repetition rates, intensity, wavelengths FWHM, Gaussian optics and mode matching, laser safety, laser light coupling. **Laser safety and hazards**: interaction of light with matter, molecular energy levels, absorption, stimulated and spontaneous emission, scattering, laser selection criteria for specific applications. **Examples of laser applications**: laser for material processing, laser based sensing or imaging. Laser for medical applications: laser surgery, laser for scientific applications, e.g. absorption spectroscopy; laser tweezers, etc. Military: laser guided missile, eye-targeted lasers, target designator.

Teaching/Learning Methodology

Lecture: The course contents will be introduced and discussed in lectures. An active participation in these learning activities can significantly enhance students' conceptual understanding, knowledge acquisition and problem-solving skills.

Student-centered Tutorial: Tutorial classes allow students to ask questions related to abstract and difficult learning content, followed by in-depth explanation and discussion, resulting in fostering their skills in analytical power, concept acquisition, critical thinking, problem-solving and life-long learning.

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
(1) Continuous assessment	40	✓	✓	✓	✓	✓
(2) Examination	60	✓	✓	✓	✓	✓
Total	100					

Continuous assessment:
The continuous assessment includes assignments, quizzes and test(s) which aim at checking the progress of students study throughout the course, assisting them in fulfilling the learning outcomes.
Assignments in general include end-of-chapter problems, which are used to reinforce and assess the concepts and skills acquired by the students; and to let them know the level of understanding that they are expected to reach.
At least one test would be administered during the course of the subject as a means of timely checking of learning progress by referring to the intended outcomes, and as means of checking how effective the students digest and consolidate the materials taught in the class.

Examination: This is a major assessment component of the subject. It would be a closed-book examination.

Student Study Effort Expected

Class contact:	
• Lecture	33 h
• Tutorial	6 h
Other student study effort:	
• Self-study	81 h
Total student study effort	120 h

Reading List and References

Walter Koechner, 'Solid-State Laser Engineering', 6th Edition, Springer Berlin / Heidelberg, 2010.

Gennady G. Gladush, 'Physics of Laser Materials Processing: Theory and Experiment', 1st Edition, Springer, 2011.

R. Henderson and K. Schulmeister, 'Laser Safety: For Users and Manufacturers of Laser Equipment', 2nd Edition, Taylor & Francis, 2011.