

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI, HYDERABAD CAMPUS
SECOND SEMESTER 2018 - 2019
COURSE HANDOUT (PART II)

Date: 07/01/2019

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific detail regarding the course:

Course No : **EEE F426**

Course Title : **Fiber Optics & Optoelectronics**

Instructor-in-charge: **Dr. Prasant Kumar Pattnaik**

Course Description:

Theory of optical fibers, image transmission by fibers, technology of fiber production, fiber testing, characterization of optical fibers, detectors and sources for fiber optic systems; active fibers, applications of optical fibers; optoelectronic devices and applications.

Scope & Objective:

In the recent past, tremendous advances have been achieved in fiber optics and associated optoelectronics. These developments have made fiber - optic communication synonymous with the current worldwide revolution in information technology.

This course aims at providing the undergraduates with a firm grounding in the major aspects of this emerging technology. Thus the course deals with the study of various building blocks of fiber optic systems, e.g. optical fibers, sources, detectors, modulators, optical amplifiers, etc. together with overall system design and performance analysis for communication as well as sensing.

Text Book: Khare, R.P.: "Fiber Optics and Optoelectronics" Oxford University Press (2004)

Reference Book: Agrawal, G.P.: "Fiber-optic communication systems" (3rd Ed) John Wiley, N.Y. (2002)

Course Plan:

| Lect. No. | Learning Objectives | Topic (s) to be covered | Chapter in the Text Book |
|-----------|---|---|--------------------------|
| 1. | i. What is the basic configuration of a fiber-optic system? | A generalized configuration of a fiber optic system | Chap1./Sec 1.1 – 1.3 |
| | ii. What are the merits of such a system? | Attractive features. | Chap1/Sec.1.4 |
| | iii. What role are they going to play in the sociological evaluation? | The role of fiber optic systems. | Chap1/Sec. 1.5-1.6 |
| 2. | How rays propagate through different types of optical fibers? | Review of fundamental laws of optics | Chap2/Sec.2.2 |
| | | Ray propagation in step index fibers | Chap2/Sec 2.3 |
| | | Ray propagation in graded index fibers | Chap2/Sec. 2.4 |
| 3. | To estimate the causes of pulse broadening. | Effect of material dispersion | Chap2/Sec. 2.5 |
| | | Effect of multipath-dispersion and combined effect | Chap2/Sec. 2.6 |
| 4. | Learning the calculation of different parameters of optical fibers. | Numerical problems | Review Q. of Chap2 |
| 5. | Familiarization with the background for learning electromagnetic wave propagation | Maxwell's equations | Chap3/Sec. 3.2 |
| | | Solution in an inhomogeneous medium | Chap3/Sec. 3.3 |

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| 6. | Modal analysis of planar optical wave guides | Planar optical waveguide TE modes of a symmetric step index planar waveguide | Chap3/Sec. 3.4 Chap3/Sec. 3.5 |
| 7. | Modal analysis contd. | Power distribution and confinement factor | Chap3/Sec. 3.6 |
| 8. | Reinforcing concepts | Numerical Problems | Review Q. of Chap3 |
| 9. | Modal analysis of cylindrical optical waveguide. | Wave propagation in an ideal s.i fiber | Chap 4/Sec 4.2 |
| 10. | Modal analysis contd. | Modal power distribution in s.i. fibers | Chap4/Sec. 4.3 |
| 11. | Modal analysis contd | Wave propagation in graded index fiber | Chap4/Sec. 4.4 |
| 12. | Propagation through Single mode fibers | Characteristic parameters of SM fibers | Chap 5/ Sec.5.2-5.3 |
| 13. | Single mode fibers contd | Dispersion in SM fibers | Chap 5/Sec. 5.4 |
| | | Attenuation in SM fibers | Chap 5/Sec. 5.5 |
| 14. | Single mode fibers contd | Design of SM fibers and related problems | Chap5/Sec. 5.6 & review Q. |
| 15. | Fabrication of low loss optical fibers | Fiber material requirements | Chap6/Sec. 6.2 |
| | | Fiber fabrication methods | Chap6/Sec. 6.3 |
| 16. | Design aspects of optical fiber cables and connections | Fiber optic cables, connection and related losses | Chap6/Sec. 6.4 – 6.7 |
| 17. | Evaluating the performance of optical fibers | Characterization of optical fibers | Chap6/Sec 6.8 |
| 18. | To understand the fundamental aspects of optoelectronic sources | Intrinsic and extrinsic semi-conductors | Chap7/Sec. 7.2 |
| | | p-n junction, Life time and diffusion length of minority carriers | Chap7/Sec. 7.3 |
| 19. | Fundamental aspects of optoelectronic sources contd | Current density and injection efficiency | Chap 7/Sec.7.4 |
| 20. | Principle of operation of light emitting diodes(LED) | LED, its internal and external quantum efficiency | Chap7/Sec. 7.5 |
| 21. | Design aspects of LED | Heterojunction | Chap7/Sec. 7.6 |
| | | LED designs | Chap7/Sec7.7 |
| 22. | Principles of injection laser diode (ILD) | ILD, condition for laser action, laser modes & laser action in semi conductors | Chap7/Sec. 7.9 –7..9.3 |
| 23. | Design aspects of ILD and source fiber coupling | ILD structures | Chap7/Sec.7-9.5 |
| | | Source Fiber coupling | Chap7/Sec. 7.10 |
| 24. | Reinforcing concepts | Problems of Chap 7 | Review Q. of Chap7 |
| 25. | Principle of operation and types of optoelectronic detectors. | Basic principle of opto-electronic detection | Chap8/Sec. 8.2 to 8.3 |
| | | Types of photodiodes | Chap8/Sec 8.4 |
| 26. | Reinforcing concepts | Problems of Chap 8. | Review Q. of Chap 8 |
| 27. | Review of basic principles of optoelectronic modulator | Polarization, birefringence, retardation plates | Chap9/Sec. 9.1 & 9.2 |
| 28. | Electro optic effect and related modulators | Electro optic modulators and related problems | Chap9/Sec 9.3 |

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| 29. | Acousto-optic effect and related modulators | Acousto-optic modulators & related problems. | Chap9/Sec. 9.4 |
| 30. | Optical amplification | Semiconductor optical amplifiers | Chap.10/Sec 10.2 |
| 31. | Optical amplification contd | Erbium doped fiber amplifiers | Chap. 10/ Sec. 10.3 |
| 32. | Optical amplification contd | Fiber Raman amplifiers | Chap 10/Sec. 10.4 |
| 33. | Wavelength division multiplexing | WDM and DWDM | Chap. 11/Sec. 11.2 – 11.3 |
| 34. | WDM contd | Components | Chap. 11/Sec. 11.4 |
| 35. | Fiber- optic communication systems | System design considerations | Chap. 12/Sec. 12.2 |
| 36. | Fiber- optic communication systems contd | System architectures | Chap. 12/Sec.12.3 |
| 37. | Fiber- optic communication systems contd | Non-linear effects and system performance | Chap. 12/Sec. 12.4 – 12.5 |
| 38. | Fiber optic sensors (FOS) | What is FOS? Classification of fos, Intensity-modulated fos | Chap. 13/Sec. 13.2 – 13.4 |
| 39. | Fiber optic sensors (FOS) contd | Phase-modulated and spectrally-modulated fos | Chap. 13/ Sec. 13.5 – 13.6 |
| 40. | Fiber optic sensors (FOS) contd | Distributed fos and Smart Structures | Chap. 13/ Sec. 13.7- 13.9 |
| 41. | Laser-based systems | Different types of lasers | Chap. 14 / Sec14.2 –14.6 |
| 42. | Laser-based systems contd | Applications of lasers | Chap. 14 / Sec. 14.7 |

Evaluation Scheme:

| EC. No. | Evaluation Component | Duration | Weightage (Percentage) | Marks | Date, Time & Venue | Nature of Component |
|---------|----------------------|-------------|------------------------|-------|------------------------|---------------------|
| 1. | Midsem | 90 min. | 30 | 90 | 15/3 3.30 - 5.00 PM | CB |
| 2. | Assignments | ---- | 20 | 60 | --- | OB |
| 3. | Quizzes | 20 min each | 10 | 30 | During class hour | CB |
| 4. | Comprehensive Exam | 3 hrs. | 40 | 120 | 11/05 AN | CB |

Chamber Consultation Hour: To be announced in class

Notices: Notices concerning this course will be displayed on CMS

Make-up Policy: No make-up will be given for Quizzes and Assignments. However, for mid-semester test and comprehensive exam, make-up examination will be given as per AUGSD rules and regulations.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Dr. Prasant Kumar Pattnaik
Instructor-in-charge, EA C422