# Academic Course Description

BHARATH University
Faculty of Engineering and Technology
Department of Electronics and Communication Engineering

## BEC701 Fiber Optic Communication

**Seventh Semester, 2017-18 (Odd Semester)**

**Course (catalog) description**

This course is intended to bring to the students the information necessary to understand the design, operation and capabilities of fiber systems. Students will be introduced to the fundamental concepts of various optical components. Latest topics are included to keep in touch with the recent trends

**Compulsory/Elective course:** Compulsory for ECE students

**Credit & contact hours** **:** 3 & 45

**Course Coordinator** **: Ms.Saravana**, Assoc.Professor,Department of ECE
**Instructor(s)** **:**

| Name of the instructor | Class handling | Office location | Office phone | Email (domain: @bharathuniv.ac.in) | Consultation |
|---|---|---|---|---|---|
| Ms.Saravana | IV ECE | SA block | | | 12.45-1.15 PM |

**Relationship to other courses**

*Pre-requisites* : Electromagnetic Fields and waves.

*Assumed knowledge* : Basic Knowledge in Optical fiber fundamentals and communication

*Following courses* : BET603-Telecommunication Switching Systems

**Syllabus Contents**

***UNIT 1 INTRODUCTION TO OPTICAL FIBER*** ***( 9 Hours)***

Evolution of fiber Optic system – Element of an Optical Fiber Transmission link – Ray Optics – Optical Fiber Modes and Configurations – Mode theory of Circular Wave guides – Overview of Modes – Key Modal concepts – Linearly Polarized Modes – Single Mode Fibers – Graded Index fiber structure

***UNIT 2 SIGNAL DEGRADATION IN OPTICAL FIBER*** ***( 9 Hours)***

Attenuation – Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Wave guides – Information Capacity determination – Group Delay – Material Dispersion, Wave guide Dispersion, Signal distortion in SM fibers – Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in GI fibers – Mode Coupling – Design Optimization of SM fibers – RI profile and cut-off wavelength.

***UNIT 3 FIBER OPTICAL SOURCES*** ***( 9 Hours)***

Direct and indirect Band gap materials – LED structures – Light source materials – Quantum efficiency and LED power, Modulation of a LED, Laser Diodes – Modes and Threshold condition – Rate equations – External Quantum efficiency – Resonant frequencies – Laser Diodes structures and radiation patterns – Single Mode lasers – Modulation of Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers.

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***UNIT 4 FIBER OPTICAL RECEIVERS*** ***( 9 Hours)***

PIN and APD diodes – Photo detector noise, SNR, Detector Response time, Avalanche multiplication Noise – Comparison of Photo detectors – Fundamental Receiver Operation – pre-amplifiers - Error Sources – Receiver Configuration – Probability of Error – The Quantum Limit.

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***UNIT 5 DIGITAL TRANMISSION SYSTEM*** ***( 9 Hours)***

Point-to-Point links – System considerations – Fiber Splicing and connectors – Link Power budget – Rise-time budget – Noise Effects on System Performance – Operational Principals of WDM, Solutions.

***TOTAL 45***

**Text book(s) and/or required materials**

**TEXT BOOK**

*T1.Gerd Keiser, —Optical Fiber Communications ||Tata McGraw– Hill education private Limited, New Delhi, fifth Edition, 2008, Reprint 2009.*

**REFERENCES**

*R2 J. Senior, —Optical Communication, Principles and Practice||, Prentice Hall of India, third Edition, 2004.*

*R3.J.Gower, —Optical Communication System||, Prentice Hall of India, 2001*

*R4.Yarvi.A.||QuantumEletronics||, John Wiley 4th edition, 1995*

**Computer usage:** Nil

**Professional component**

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|---|---|---|
| General | - | 0% |
| Basic Sciences | - | 0% |
| Engineering sciences & Technical arts | - | 0% |
| Professional subject | - | 100% |

**Broad area : Communication**

**Test Schedule**

| S. No. | Test | Tentative Date | Portions | Duration |
|---|---|---|---|---|
| 1 | Cycle Test-1 | August 1st week | Session 1 to 14 | 2 Periods |
| 2 | Cycle Test-2 | September 2nd week | Session 15 to 28 | 2 Periods |
| 3 | Model Test | October 2nd week | Session 1 to 45 | 3 Hrs |
| 5 | University Examination | TBA | All sessions / Units | 3 Hrs. |

**Mapping of Instructional Objectives with Program Outcome**

| To learn the basic elements of optical fiber transmission link, fiber modes, configurations and structures, different kind of losses, signal distortion, SM fibers, optical sources, Materials and fiber splicing, fiber optic receivers ,noise performance in photo detectors, link budget, WDM, solitons and SONET/SDH network.<br>This course emphasizes: | **Correlates to program outcome** | | |
|---|---|---|---|
| | **H** | **M** | **L** |
| **1.** Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber. | a,h | C,f | - |
| **2.** Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers | c,g,j | a | b,i |
| **3.** Describe the principles of optical sources and power launching coupling methods | b,d,k | a,f | g |
| **4.** Compare the characteristics of fiber optic receivers**.** | b.d | a,i,k | |
| **5.** Design a fiber optic link based on budgets | | e,f,g,k | b,i |
| **6.** To access the different techniques to improve the capacity of the system | f | d.g | |

H: high correlation, M: medium correlation, L: low correlation

**Draft Lecture Schedule**

| **Session** | **Topics** | **Problem Solving (Yes/No)** | **Text / Chapter** |
|---|---|---|---|
| **UNIT 1 INTRODUCTION TO OPTICAL FIBER** | | | |
| 1. | Introduction, Evolution of fiber Optic system | No | [T1] chapter-1,2<br>[R1]chapter-3 |
| 2. | Element of an Optical Fiber Transmission link | No | |
| 3. | Ray Optics | No | |
| 4. | Optical Fiber Modes and Configurations | Yes | |
| 5. | Mode theory of Circular Wave guides | Yes | |
| 6. | Overview of Modes, Key Modal concepts | Yes | |
| 7. | Linearly Polarized Modes | Yes | |
| 8. | Single Mode Fibers | Yes | |
| 9. | Graded Index fiber structure | Yes | |
| **UNIT 2 SIGNAL DEGRADATION IN OPTICAL FIBER** | | | |
| 10. | Attenuation – Absorption losses | No | [T1] chapter –3<br>[R1]chapter-3 |
| 11. | Scattering losses, Bending Losses, Core and Cladding losses | No | |
| 12. | Signal Distortion in Optical Wave guides | No | |
| 13. | Information Capacity determination – Group Delay | Yes | |
| 14. | Material Dispersion, Wave guide Dispersion | Yes | |
| 15. | Signal distortion in SM fibers – Polarization Mode dispersion | Yes | |
| 16. | Intermodal dispersion, Pulse Broadening in GI fibers | No | |
| 17. | Mode Coupling , Design Optimization of SM fibers | Yes | |
| 18. | RI profile and cut-off wavelength | No | |

| Session | Topics | Problem Solving (Yes/No) | Text / Chapter |
|---|---|---|---|
| **UNIT 3 FIBER OPTICAL SOURCES** | | | |
| 19. | Direct and indirect Band gap materials | No | [T1] chapter – 4<br>[R1] chapter - 6 |
| 20. | LED structures, Quantum efficiency and LED power | No | |
| 21. | Modulation of a LED | No | |
| 22. | Laser Diodes – Modes and Threshold condition – Rate equations | Yes | |
| 23. | External Quantum efficiency, Resonant frequencies | Yes | |
| 24. | Laser Diodes structures and radiation patterns | No | |
| 25. | Single Mode lasers, Modulation of Laser Diodes | Yes | |
| 26. | Temperature effects, Introduction to Quantum laser | No | |
| 27. | Fiber amplifiers | No | |
| **UNIT 4 FIBER OPTICAL RECEIVERS** | | | |
| 28. | PIN and APD diodes | No | [T1] chapter–7,6<br>[R1] chapter–2 |
| 29. | Photo detector noise | No | |
| 30. | SNR, Detector Response time | Yes | |
| 31. | Avalanche multiplication Noise | Yes | |
| 32. | Comparison of Photo detectors | No | |
| 33. | Fundamental Receiver Operation | No | |
| 34. | Pre-amplifiers, Error Sources | No | |
| 35. | Receiver Configuration | No | |
| 36. | Probability of Error – The Quantum Limit | Yes | |
| **UNIT 5 DIGITAL TRANMISSION SYSTEM** | | | |
| 36. | Point-to-Point links | No | [T1] chapter– 8,11<br>[R1] chapter-9 |
| 37. | System considerations | No | |
| 38. | Fiber Splicing | No | |
| 39. | Fiber connectors | No | |
| 40. | Link Power budget | Yes | |
| 41. | Rise-time budget | Yes | |
| 42. | Noise Effects on System Performance-Modal noise, Partition noise | No | |
| 43. | Chirping and Reflection noise | No | |
| 44. | Operational Principals of WDM | No | |
| 45. | Solitons | No | |

**Teaching Strategies**

The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Formal face-to-face lectures
- Tutorials, which allow for exercises in problem solving and allow time for students to resolve problems in understanding of lecture material.
- Laboratory sessions, which support the formal lecture material and also provide the student with practical construction, measurement and debugging skills.
- Small periodic quizzes, to enable you to assess your understanding of the concepts.

**Evaluation Strategies**

| | | |
|---|---|---|
| Cycle Test – I | - | 5% |
| Cycle Test – II | - | 5% |
| Model Test | - | 10% |
| Assignments/Seminar/online test/quiz | - | 5% |
| Attendance | - | 5% |
| Final exam | - | 70% |

**Prepared by: Ms.**Saravana, Assoc Professor, Department of ECE **Dated :**

**Addendum**

***ABET Outcomes expected of graduates of B.Tech / ECE / program by the time that they graduate:***

a. An ability to apply knowledge of mathematics, science, and engineering

b. An ability to design and conduct experiments, as well as to analyze and interpret data

c. An ability to design a hardware and software system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

d. An ability to function on multidisciplinary teams

e. An ability to identify, formulate, and solve engineering problems

f. An understanding of professional and ethical responsibility

g. An ability to communicate effectively

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

i. A recognition of the need for, and an ability to engage in life-long learning

j. A knowledge of contemporary issues

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

***Program Educational Objectives***

**PEO1: PREPARATION**

Electronics Engineering graduates are provided with a strong foundation to passionately apply the fundamental principles of mathematics, science, and engineering knowledge to solve technical problems and also to combine fundamental knowledge of engineering principles with modern techniques to solve realistic, unstructured problems that arise in the field of Engineering and non-engineering efficiently and cost effectively.

**PEO2: CORE COMPETENCE**

Electronics engineering graduates have proficiency to enhance the skills and experience to apply their engineering knowledge, critical thinking and problem solving abilities in professional engineering practice for a wide variety of technical applications, including the design and usage of modern tools for improvement in the field of Electronics and Communication Engineering**.**

**PEO3: PROFESSIONALISM**

Electronics Engineering Graduates will be expected to pursue life-long learning by successfully participating in post graduate or any other professional program for continuous improvement which is a requisite for a successful engineer to become a leader in the work force or educational sector.

**PEO4: SKILL**

Electronics Engineering Graduates will become skilled in soft skills such as proficiency in many languages, technical communication, verbal, logical, analytical, comprehension, team building, interpersonal relationship, group discussion and leadership ability to become a better professional.

**PEO5: ETHICS**

Electronics Engineering Graduates are morally boosted to make decisions that are ethical, safe and environmentally-responsible and also to innovate continuously for societal improvement.

| Course Teacher | Signature |
|---|---|
| Ms.Saravana | |
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**Course Coordinator** **HOD/ECE**