**Course File**

***Subject Title/Subject Code: Fiber optics communications/6EC4-03***

Semester: VI Year: III

|  |  |  |
| --- | --- | --- |
| Name of the Faculty: Ms. Akansha Suthar |  | |
|  |  | |
| E-mail id: akansha.suthar@technonjr.org |  |

**Class Schedule**

**Total Number of Lectures:** 40

i**)Course Objective**

**Student will learn fundamentals of Fiber optic communication from this 40-hour course. In this course, student will study the fundamental concepts and application of optical communication. They will study different optical measurement like noise analysis, attenuation signal degradation calculation etc. using devices like OTDR. Also, they will be able to design the different optical devices like sources, detectors and amplifiers.**

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**VISSION & MISSION OF INSTITUTE**

## Vision

Empowering student with recent and emerging technologies to create innovative technical leaders capable of contributing to industrial and societal needs for betterment of mankind across the globe.

## Mission

**M1**: To provide dynamic learning environment to students by providing constant exposure to latest technologies by linking closely with the industries.

**M2**: To establish effective interface with industry to obtain live problems to enhance critical thinking and problem solving skills among students and consultancy projects for faculty.

**M3**: To provide avenues and opportunities to faculty for domain specific trainings and qualification upgradation.

**M4**: To develop ethical leaders with strong communication skills.

**VISION & MISSION OF DEPARTMENT**

**Department Vision**

To increase student’s learning of fundamentals of programming and latest technologies of IOT through industry-aligned project-based learning transforming students to be good Embedded and IT Professionals leading to innovation and incubation of new ideas.

**Department Mission**

**M1:** To create experimental learning through solving problems of Government, Society, Smart Cities, Industry and other entities.

**M2:** To teach the latest technologies of IOT and Programming Skills to the students as beyond the syllabus activity so that they are updated and industry ready.

**M3:** To enable engineering students understand industry-aligned technologies and learn to find solutions from their early engineering days and this is the only way to produce globally relevant engineers solving real-life problems applying current technologies.

**M4:** To enable students to generate projects through problem faced by and requirement of Smart cities, industry, Government and other entities whereby those outlined problem statements are to be studied deeply by a group of faculty members to convert them into real-time project format.

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

**PEOs1:** Core Knowledge Development: Be competent in applying electronics and communication engineering principles to develop socially and environmentally acceptable engineering solutions.

**PEOs2:** Professional development: Have fulfilling career in electronic and communication engineering or associated industries or higher education and research, or as entrepreneurs.

**PEOs3:** Attitude towards lifelong learning: Enhance the ability and attitude to adapt to evolving technological and social challenges.

**PROGRAM SPECIFIC OUTCOMES (PSO's)**

**PSO1**: To be aware of and initiate some work on programming and new developments which may impact future embedded and IT industry jobs.

**PSO2**: Design and development of Embedded and IOT based systems.

**PSO3**: Get exposure to Embedded and IT Industry work culture

**PROGRAMME OUTCOMES (POs)**

**A student will develop:**

**PO01. ENGINEERING KNOWLEDGE:** Acquire the knowledge of mathematics, science, engineering fundamentals, and electronics and communication engineering, with an ability to understand, analyze and apply to the solution of engineering problems..

**PO02. PROBLEM ANALYSIS:** Identify, formulate, research literature, analyse and solve electronics and communication engineering problems.

**PO03. DESIGN/ DEVELOPMENT OF SOLUTION:** Design solutions for electronics and communication engineering problems with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO04. CONDUCTION OF INVESTIGATION OF COMPLEX PROBLEMS:** Design and conduct experiments, analyse and interpret data, and synthesize information to provide valid conclusions.

**PO05. MODERN TOOL USAGE:** Apply appropriate techniques, resources, and modern hardware and software engineering tools to solve electronics and communication engineering problems.

**PO06. THE ENGINEERING AND SOCIETY:** Apply reasoning to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO07. ENVIRONMENT & SUSTAINABILITY:** Demonstrate the understanding of the impact of the professional engineering solutions in societal and environmental contexts, and need for sustainable development.

**PO08. ETHICS:** Demonstrate the knowledge of professional and ethical responsibilities..

**PO09. INDIVIDUAL AND TEAM WORK:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. COMMUNICATION:** Comprehend and communicate confidently and effectively in both verbal and written form.

**PO11. PROJECT MANAGEMENT & FINANCE:** Apply the engineering and management principles for efficient project management.

**PO12. LIFE-LONG LEARNING:** Recognize the need and acquire confidence for independent and life-long learning.

**COURSE OUTCOMES (COs) OF THE SUBJECT**

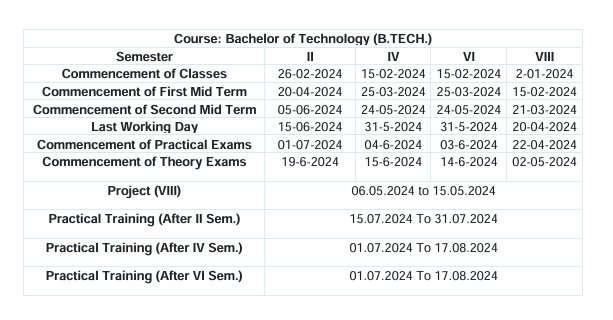
|  |  |  |
| --- | --- | --- |
| CO No. | Mapping | Statement |
| CO36403.1 | **Knowledge** | Explain basic knowledge of Ray theory principle & optical fibber working concepts. . |
| CO36403.2 | **Comprehension** | The knowledge of optical communication subject helps the students to perform various experiments in laboratories which will help in understanding theory more clearly. |
| CO36403.3 | **Analysis** | Analyze the use of modern upcoming technologies in optical communication. |
| CO36403.4 | **Synthesis** | Design tools for optical system design, test and evaluation. |
| CO36403.5 | **Evaluation** | Evaluate the performance of optical components. |

**COS MAPPING WITH POs AND PSOs**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Outcome** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
| **CO1** | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| **CO2** | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| **CO3** | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| **CO4** | 1 | 2 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 |
| **CO5** | 2 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**UNIVERSITY ACADEMIC CALENDAR**

Academic Calendar for Even Semester for Session



**Evaluation Scheme**

FACULTY DETAILS:

Name of the Faculty : Ms. Akansha Suthar

Designation : Assistant Professor

Department : Electronics and Communication Engineering

1. TARGET

a) Percentage Pass : 95%

b) Percentage I class : 60 %

2. METHOD OF EVALUATION

2.1. Continuous Assessment Examinations (Mid-Term 1, Mid-Term 2)

2.2. Assignments / Seminars

2.3. Mini Projects

2.4. Quiz

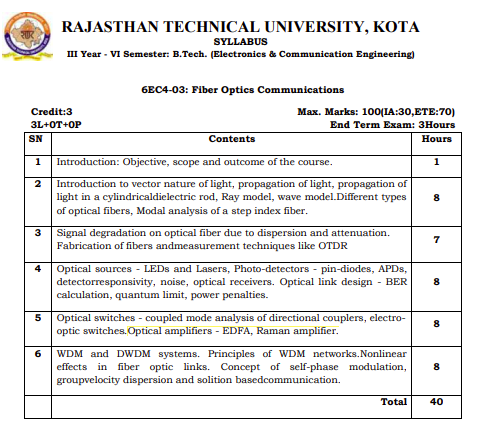
2.5. Semester Examination Others\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. List out any new topic(s) or any innovation you would like to introduce in teaching the subject in this Semester.

1. Take the help of creative tools to stimulate creativity. Include slide presentations, demonstration or forms of visual exercises that will excite the young minds and capture their interest.

Signature of Faculty: **Signature of HOD**

**UNIVERSITY SYLLABUS**

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**PRESCRIBED BOOKS**

1. Optical Fiber Communications, G. Keiser, TMH

2. Optical Fiber Communications Principles and Practices, John M. Senior, PHI

3. Optical Communication Systems, J. Gowar, PHI

**WEEKLY TIME TABLE OF THE TEACHER**

First Time Table: with effect from (Date): 20-02-2024

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Day** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Monday |  |  |  |  |  |  |  |
| Tuesday |  |  |  |  |  |  |  |
| Wednesday |  | FOC |  |  |  |  |  |
| Thursday |  | FOC |  |  |  |  |  |
| Friday |  |  |  |  |  |  |  |
| Saturday | FOC |  |  |  |  |  |  |

Revision: 1 with effect from (Date): 29-04-2024

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Day** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Monday |  |  |  |  |  |  |  |
| Tuesday |  |  |  |  |  |  |  |
| Wednesday |  |  | FOC |  |  |  |  |
| Thursday |  |  |  | FOC |  |  |  |
| Friday | FOC |  |  |  |  |  |  |
| Saturday | FOC |  |  |  |  |  |  |

**COURSE-PLAN**

|  |  |  |  |
| --- | --- | --- | --- |
| UNIT | Lect.  No. | TOPICS | **Teaching Methods/ Teaching Aids** |
| **1** | **1** | **OPTICAL FIBER OVERVIEW:** Introduction, Ray theory, | White Board |
| 1 | 2 | Optical fibers: multimode, single mode, step index, graded index | White Board |
| 1 | 3 | plastic & glass fibers. | White Board |
| 1 | 4 | **TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS:** Introduction, Attenuation, | White Board |
| 1 | 5 | Material absorption loss, Fiber bend loss | White Board |
| 1 | 6 | scattering, Dispersion (intermodal & intramodal), | White Board |
| 1 | 7 | Dispersion Shifted Fibers, Dispersion Compensating Fiber | White Board |
| 1 | 8 | **MANUFACTURING OF OPTICAL FIBERS:** preparation of optical fiber | White Board |
| 1 | 9 | Liquid phase techniques, vapor phase depositions techniques | White Board |
| 2 | 10 | **OPTICAL FIBER SOURCES:** Laser- Emission and absorption of radiation | White Board |
| 2 | 11 | Einstein relation, Absorption of radiation | White Board |
| 2 | 12 | Population inversion | White Board |
| 2 | 13 | Optical feedback | White Board |
| 2 | 14 | Threshold condition | White Board |
| 2 | 15 | Population inversion and threshold | White Board |
| 2 | 16 | working of three levels & four level lasers | White Board |
| 2 | 17 | Basic idea of solid state | White Board |
| 2 | 18 | semiconductors, gas & liquid laser | White Board |
| 2 | 19 | Basic concept of Q-switching and mode locking. | White Board |
| 2 | 20 | Light Emitting Diode - Structure, Material, | White Board |
| 2 | 21 | LED Characteristics, Power & Efficiency, Numerical | White Board |
| 3 | 22 | **OPTICAL DETECTORS:**Optical detection principles, quantum efficiency | White Board |
| 3 | 23 | Responsivity, PIN photo diode | White Board |
| 3 | 24 | Avalanche photo diodes, Noise in Detectors | White Board |
| 3 | 25 | Photo Diode Materials | White Board |
| 3 | 26 | Optical Connectors: Fiber Alignment | White Board |
| 3 | 27 | fiber splices, fiber connectors | White Board |
| 3 | 28 | expanded beam connectors, fiber couplers& numerical | White Board |
| 4 | 29 | **OPTICAL FIBER MEASUREMENTS:**Measurements of Fiber Attenuation | White Board |
| 4 | 30 | Dispersion, Refractive Index Profile, | White Board |
| 4 | 31 | Cut off Wave Length, Numerical Aperture & Diameter | White Board |
| 4 | 32 | Optical Time Domain Reflectometry (OTDR) - Field measurement through optical time domain reflectometry | White Board |
| 4 | 33 | Laser based systems for measurement of distance | White Board |
| 4 | 34 | Laser based systems for measurement of Velocity | White Board |
| 5 | 35 | Holography, Numerical | White Board |
| 5 | 36 | **OPTICAL FIBER SYSTEMS:**Wavelength division multiplexing | White Board |
| 5 | 37 | DWDM, active and passive components | White Board |
| 5 | 38 | optical sensors, optical amplifiers | White Board |
| 5 | 39 | Optical Fiber Applications:public network applications, military | White Board |
| 5 | 40 | Optical fiber application in civil and industrial applications, Numerical | White Board |

**Signature of Faculty: Signature of HOD**

**Assignment – 1**

1. What is optical fiber? Point out it advantages. (CO1)
2. Define NA of optical fiber. How it is related with the acceptance angle for an optical fiber? (CO1)
3. What is pulse dispersion in optical fiber? It depends on which parameters? Briefly discuss the reasons and hence estimate its magnitudes in. (CO2)

(a) SIF

(b) GIF fibers.

1. What do you mean by signal attenuation in optical fiber? Briefly discuss the signal loss in optical fiber due to (CO2)

(a) absorption process

(b) scattering process

(c) finite bending of fiber.

1. Estimate the power loss of optical fiber in percentage (%), corresponding the signal loss of ~ 6 dB/ KM. (CO3)
2. Light form a LED source having λ = 0.85 μm and intrinsic spectral width ~ Δλ = 25 nm is coupled through a silica fiber with material dispersion ~ 4 x 1010/ m2 . Calculate the pulse dispersion for this system. (CO3)

**Assignment – 2**

1. Light from a source placed in air is coupled to a SIF having core RI = 1.53 and cladding RI = 1.50. Estimate the maximum angle of acceptance (αm) of signal in to the fiber from the source. (CO4)
2. What is critical bending criteria for fiber installation? Point out the methods of fiber coupling for (a) permanent and (b) temporary joins during installations. (CO4)
3. How optical fibres are prepared? With system diagram discuss briefly the (a) liquid phase and (b) vapor phase growth methods for fiber productions. (CO4)
4. Explain the significance of link power budget and rise time budget with one illustration for each. (CO5)
5. Explain the principles of WDM (CO5)
6. Describe the operation of unidirectional and bidirectional WDM (CO5)

**SAMPLE QUIZ QUESTIONS**

1.Multimode step index fiber has \_\_\_\_\_\_\_\_\_\_\_  
a) Large core diameter & large numerical aperture  
b) Large core diameter and small numerical aperture  
c) Small core diameter and large numerical aperture  
d) Small core diameter & small numerical aperture

2. A typically structured glass multimode step index fiber shows as variation of attenuation in range of \_\_\_\_\_\_\_\_\_\_\_  
a) 1.2 to 90 dB km-1 at wavelength 0.69μm  
b) 3.2 to 30 dB km-1 at wavelength 0.59μm  
c) 2.6 to 50 dB km-1 at wavelength 0.85μm  
d) 1.6 to 60 dB km-1 at wavelength 0.90μm

3. Multimode step index fiber has a large core diameter of range is \_\_\_\_\_\_\_\_\_\_\_  
a) 100 to 300 μm  
b) 100 to 300 nm  
c) 200 to 500 μm  
d) 200 to 500 nm

4. The fibers mostly not used nowadays for optical fiber communication system are \_\_\_\_\_\_\_\_\_\_\_  
a) Single mode fibers  
b) Multimode step fibers  
c) Coaxial cables  
d) Multimode graded index fibers

5. Single mode fibers allow single mode propagation; the cladding diameter must be at least \_\_\_\_\_\_\_\_\_\_\_  
a) Twice the core diameter  
b) Thrice the core diameter  
c) Five times the core diameter  
d) Ten times the core diameter

6.Fiber mostly suited in single-wavelength transmission in O-band is?  
a) Low-water-peak non dispersion-shifted fibers  
b) Standard single mode fibers  
c) Low minimized fibers  
d) Non-zero-dispersion-shifted fibers

7. Which of the following statements best explain the concept of material absorption?  
a) A loss mechanism related to the material composition and fabrication of fiber  
b) A transmission loss for optical fibers  
c) Results in attenuation of transmitted light  
d) Causes of transfer of optical power

8. How many mechanisms are there which causes absorption?  
a) One  
b) Three  
c) Two  
d) Four

9.A multimode fiber has refractive indices n1 = 1.15, n2 = 1.11 and an operating wavelength of 0.7μm. Find the radius of curvature?  
a) 8.60μm  
b) 9.30μm  
c) 9.1μm  
d) 10.2μm

10. A single mode fiber has refractive indices n1=1.50, n2 = 2.23, core diameter of 8μm, wavelength = 1.5μm cutoff wavelength = 1.214μm. Find the radius of curvature?  
a) 12 mm  
b) 20 mm  
c) 34 mm  
d) 36 mm

11. How the potential macro bending losses can be reduced in case of multimode fiber?  
a) By designing fibers with large relative refractive index differences  
b) By maintaining direction of propagation  
c) By reducing the bend  
d) By operating at larger wavelengths

12. Sharp bends or micro bends causes significant losses in fiber.  
a) True  
b) False

13. The \_\_\_\_\_\_\_\_\_\_\_\_ affects the light gathering capacity and the normalized frequency of the fiber.  
a) Numerical aperture  
b) Amplitude modulation  
c) Responsivity  
d) Quantum efficiency

14. The numerical aperture for a step index fiber is sine angle of the \_\_\_\_\_\_\_\_\_\_\_\_  
a) Efficient angle  
b) Aperture  
c) Acceptance angle  
d) Attenuation

15. The calculations of the numerical aperture from a refractive index data are less accurate for the graded index fibers than for step index fibers.  
a) False  
b) True

16. What is the minimum value of accuracy in diameter is needed to avoid radiation losses in the fiber?  
a) 0.1%  
b) 0.2%  
c) 0.3%  
d) 0.03%

17. Which of the following is a non-contacting optical method of on-line diameter measurement?  
a) Brussels’s method  
b) Velocity differentiator method  
c) Photo detector method  
d) Image projection method

18. The shadow method is used for measurement of the outer diameter of an optical fiber. The apparatus employs a rotating mirror with an angular velocity of 4 rad/s which is located at 10 cm from the photo detector. Compute the shadow velocity.  
a) 0.1 μm μs-1  
b) 0.4 μm μs-1  
c) 0.87 μm μs-1  
d) 1 μm μs-1

19.The shadow velocity is given by 0.4 μm μs-1 and shadow pulse of width 300 μs is registered at an instant by the photodetector. Determine the outer diameter of the optical fiber in μm.  
a) 100 μm  
b) 120 μm  
c) 140 μm  
d) 90 μm

20. The techniques used to determine the refractive index profile can also be used to determine the core diameter.  
a) True  
b) False

**QUIZ ANSWER KEY**

**Q1**. a **Q2.** c **Q3.** a **Q4.** a **Q5.** d **Q6.** b **Q7.** a **Q8.**b **Q9.** b **Q10.** c

**Q11.** a **Q12.** a **Q13.** a **Q14.**c **Q15.**b **Q16.**c **Q17.**d **Q18.**b **Q19.**b **Q20.**a

**Mid Term Paper-I**

**TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR**

**B. TECH 3rd – YEAR (VI SEM.) – MT-I**

Fiber Optics Communication (6EC4-03)

**Time:** 2 Hr **Max. Marks:** 70

**Note:**

1. The paper is divided into 2 parts: Part-A and, Part-B.
2. Part-A contains 10 questions and carries 2 mark each.
3. Part-B contains 5 questions. Each question is having two options and carries 10 marks each.

Part- A (20 Marks)

|  |  |  |
| --- | --- | --- |
|  | Define Dispersion. | CO1 |
|  | Define Total internal reflection. | CO1 |
|  | Explain Acceptance angle for optical fiber communication. | CO1 |
|  | Define skew rays. | CO1 |
|  | What are the basic components of optical fibre communication? | CO2 |
|  | Write down the applications of optical fiber communication. | CO2 |
|  | A multimode step index fiber with a core diameter of 80µm and a relative index difference of 1.5% is operating at a wavelength 0.85 µm. if the core refractive index is 1.48. Calculate the normalized frequency for the fiber. | CO2 |
|  | What are the types of signal degradation in optical fiber communication? | CO3 |
|  | Define OTDR. | CO3 |
|  | Why graded index fiber with parabolic index profile is preferred? | CO3 |

Part- B (50 Marks)

|  |  |
| --- | --- |
| 1. Define Numerical aperture of optical fiber and show how it is related to the numerical aperture. | CO1 |
| Or |  |
| 1. What do you mean by step index fiber and graded index optical fiber? Give an expression for refractive index profile. | CO1 |

|  |  |
| --- | --- |
| 1. What are the advantages and disadvantages of optical fiber communication? | CO1 |
| Or |  |
| 2. An optical fiber has a numerical aperture of 0.20 and cladding refractive index of 1.59. determine:  (a) the acceptance angle of the fiber in water which has refractive index of 1.33  (b) the critical angle at core cladding interface | CO1 |

|  |  |
| --- | --- |
| 1. What is attenuation? Define linear and non linear scattering. | CO2 |
| Or |  |
| 3 A multimode graded index fiber exhibits total pulse broadening of 0.1µs over a distance of 15 km. estimate:   1. The maximum possible bandwidth on the link assuming no intersymbol interference 2. The pulse dispersion per unit length. | CO2 |

|  |  |
| --- | --- |
| 1. What is dispersion? Explain different types of dispersion. | CO2 |
| Or |  |
| 1. What do you mean by fiber bending loss? | CO2 |

|  |  |
| --- | --- |
| 5. Describe the modified chemical vapor phase deposition (MCVD) method for preparation of optical fiber. | CO3 |
| Or |  |
| 5. What is the need of Optical Time Domain Reflectometry (OTDR) in optical fiber communication? Explain the process. | CO3 |

**Marks and Gap Analysis of Mid-Term 1**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr. No.** | **Roll Number** | **Student Name** | **Mid-Term 1**  **MM-70** | **Remark**  **( Remedial Class need or not – Y/N )** |
| 1 | 21ETCEC001 | ABBAS HAKIMUDDIM FAKHRUDDIN | 56 | Y |
| 2 | 21ETCEC002 | ABHISHEK KALAL | 61 | N |
| 3 | 21ETCEC003 | ABHISHEK RAJWANIYA | 65 | Y |
| 4 | 21ETCEC004 | ALFEZ UMAR SHEIKH | 56 | N |
| 5 | 21ETCEC005 | DHAWAL PUROHIT | 61 | Y |
| 6 | 21ETCEC006 | MS HIMANSHI SONI | 68 | N |
| 7 | 21ETCEC007 | JALAJ DASHORA | 58 | N |
| 8 | 21ETCEC008 | JATIN TAILOR | 65 | N |
| 9 | 21ETCEC009 | MANAV KUMAWAT | 70 | N |
| 10 | 21ETCEC010 | MOHIT GOUR | 68 | N |
| 11 | 21ETCEC011 | RACHIT DUTT | 56 | N |
| 12 | 21ETCEC014 | SANIDHYA SHARMA | 58 | N |
| 13 | 21ETCEC016 | SHOAIB KHAN PATHAN | 58 | N |
| 14 | 21ETCEC017 | SNEHIL SHARMA | 63 | N |
| 15 | 21ETCEC018 | SUMIT ISRANI | 68 | N |
| 16 | 21ETCEC019 | Yuvraj Nagda | 65 | Y |
| 17 | 21ETCEC300 | Sahil Bohi | 56 | Y |
| 18 | 22ETCEC200 | Kushwanth | 58 | N |

**\***(Y, if obtained marks are <=70%)

**Signature of Faculty: Signature of HOD**

**Remedial Action Taken to Remove the Gaps (After Mid- Term 1)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S.no. | University Roll no. | Name of Student | Topics to be discussed in Remedial Class | Schedule Date of Remedial Class | Outcome  Achieved |
|  | 21ETCEC001 | ABBAS HAKIMUDDIM FAKHRUDDIN | Ray model, Signal degradation due to dispersion, LED, OTDR | **10/04/2024** | CO1,CO2,CO3 |
|  | 21ETCEC003 | ABHISHEK RAJWANIYA |
|  | 21ETCEC005 | DHAWAL PUROHIT |
|  | 21ETCEC019 | Yuvraj Nagda |
|  | 21ETCEC300 | Sahil Bohi |

**Signature of Faculty: Signature of HOD**

**TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR**

**B. TECH 3rd – YEAR (VI SEM.) – MT-II**

**Fiber optics Communication (6EC4-03**)

**Time:** 3 Hr **Max. Marks:** 70

**Note:**

1. The paper is divided into 2 parts: Part-A and, Part-B.
2. Part-A contains 10 questions and carries 2 mark each.
3. Part-B contains 5 questions. Each question is having two options and carries 10 marks each.

**Part- A (20 Marks)**

|  |  |  |
| --- | --- | --- |
| A. | Describe the function of core and cladding in optical fiber. | CO1 |
| B. | Give the classification of optical fiber on the basis of refractive index. | CO1 |
| C. | Define attenuation in fiber. How many factors on which attenuation is depend? | CO2 |
| D. | What do you understand by optical detector? What are the various types of optical detector? | CO2 |
| E. | Define the term responsivity of photo diode. | CO3 |
| F. | What is the requirement for optical sources to feed into a fiber? Enlist the advantage & Disadvantages of LASER & LED. | CO3 |
| G. | What is optical fiber amplifier? What are the applications of optical amplifier? | CO4 |
| H. | What do you mean by fiber couplers? | CO4 |
| I. | What is the need of WDM? | CO5 |
| J. | What do you mean by population inversion? | CO5 |

**Part- B (20 Marks)**

|  |  |
| --- | --- |
| 1. Explain the acceptance angle and numerical aperture. | CO1 |
| Or |  |
| 1. A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50µm. The fiber has a numerical aperture of 0.2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1µm. Also explain why graded index profile with parabolic index profile is preferred? | CO1 |

|  |  |
| --- | --- |
| 1. What is the need of Optical Time Domain Reflectometry (OTDR) in optical fiber communication? Explain in detail. | CO2 |
| Or |  |
| 2. Explain the types of dispersion. | CO2 |

|  |  |
| --- | --- |
| 1. Explain the importance of LASER in optical communication. Derive the rate equation for LASER diode. | CO3 |
| Or |  |
| 3. Explain the principle of avalanche photodiode (APD) and compare it with PIN photodiode. | CO3 |

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| --- | --- |
| 1. What is the difference between splices and connector? Explain different types of splices. | CO4 |
| Or |  |
| 1. What is the mechanism of optical amplifier? Explain Erbium doped fiber amplifier (EDFA) with diagram. | CO4 |

|  |  |
| --- | --- |
| 5. Describe the Wavelength Division Multiplexing (WDM) and compare it with Dense Wavelength Division Multiplexing (DWDM). | CO5 |
| Or |  |
| 1. A four-port multimode fiber FBT coupler has 60µW optical power launched into port 1. The measured output power at port 2, 3 and 4 are 0.004µW, 26µW and 27.5µW respectively. Determine the excess loss, insertion loss and coupling ratio for the device. | CO5 |

**Mid Term Exam – II**

**Marks and Gap Analysis of Mid-Term II**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr. No.** | **Roll Number** | **Student Name** | **Mid-Term 2**  **MM-70** | **Remark**  **( Remedial Class need or not – Y/N )** |
| 1 | 21ETCEC001 | ABBAS HAKIMUDDIM FAKHRUDDIN | 56 | Y |
| 2 | 21ETCEC002 | ABHISHEK KALAL | 61 | Y |
| 3 | 21ETCEC003 | ABHISHEK RAJWANIYA | 68 | N |
| 4 | 21ETCEC004 | ALFEZ UMAR SHEIKH | 63 | N |
| 5 | 21ETCEC005 | DHAWAL PUROHIT | 63 | Y |
| 6 | 21ETCEC006 | MS HIMANSHI SONI | 63 | N |
| 7 | 21ETCEC007 | JALAJ DASHORA | 63 | N |
| 8 | 21ETCEC008 | JATIN TAILOR | 63 | N |
| 9 | 21ETCEC009 | MANAV KUMAWAT | 70 | N |
| 10 | 21ETCEC010 | MOHIT GOUR | 61 | Y |
| 11 | 21ETCEC011 | RACHIT DUTT | 58 | N |
| 12 | 21ETCEC014 | SANIDHYA SHARMA | 61 | N |
| 13 | 21ETCEC016 | SHOAIB KHAN PATHAN | 61 | N |
| 14 | 21ETCEC017 | SNEHIL SHARMA | 58 | N |
| 15 | 21ETCEC018 | SUMIT ISRANI | 56 | Y |
| 16 | 21ETCEC019 | Yuvraj Nagda | 65 | N |
| 17 | 21ETCEC300 | Sahil Bohi | 68 | N |
| 18 | 22ETCEC200 | Kushwanth | 61 | N |

**\***(Y, if obtained marks are <=70%)

**Signature of Faculty: Signature of HOD**

**Remedial Action Taken to Remove the Gaps (After Mid- Term 1I)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S.no. | University Roll no. | Name of Student | Topics to be discussed in Remedial Class | Schedule Date of Remedial Class | Outcome  Achieved |
|  | 21ETCEC001 | ABBAS HAKIMUDDIM FAKHRUDDIN | Optical amplifiers - EDFA, Raman amplifier, WDM and DWDM systems | **13/06/2024** | CO3,CO4,CO5 |
|  | 21ETCEC002 | ABHISHEK KALAL |
|  | 21ETCEC005 | DHAWAL PUROHIT |
|  | 21ETCEC010 | MOHIT GOUR |
|  | 21ETCEC018 | SUMIT ISRANI |

**Signature of Faculty: Signature of HOD**

**Model Question Paper**

**TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR**

**B. TECH 3rd – YEAR (VI SEM.)**

**Fiber Optics Communication (6EC4-03**)

**Time:** 2 Hr **Max. Marks:** 70

**Note:**

1. The paper is divided into 2 parts: Part-A, Part-B and Part-C.
2. Part-A contains 10 questions and carries 2 mark each.
3. Part-B contains 7 questions. Each question carries 4 marks each. Attempt any 5 Questions
4. Part-C contains 5 questions. Each question carries 10 marks each. Attempt any 3 Questions

Part- A (20 Marks)

|  |  |  |
| --- | --- | --- |
|  | What is graded index fiber? How it works? What are its major advantages? | CO1 |
|  | Write short notes on ray optics theory. | CO1 |
|  | State Snell’s Law. | CO2 |
|  | Define – Acceptance Angle | CO2 |
|  | For a fiber with core refractive index of 1.54 and fractional refractive index difference of 0.01. Calculate its numerical aperture | CO3 |
|  | What is Rayleigh scattering? | CO3 |
|  | What are the different types of dispersion? | CO4 |
|  | What do you mean by hetero junction? Mention its advantages? | CO4 |
|  | Distinguish direct and indirect band- gap materials. | CO5 |
|  | Describe the term Quantum Limit. | CO5 |

Part- B (20 Marks)

|  |  |
| --- | --- |
| 1. Explain with neat diagram the elements of an optical fiber transmission link | CO1 |
| 1. A fiber has a core radius of 25mm, core refractive index of 1.48 and relative refractive index difference is 0.01. If the operating wavelength is 0.84mm, find the value of normalized frequency and the number of guided modes. Determine the number of guided modes if D is reduced to 0.03 | CO1 |

|  |  |
| --- | --- |
| 3. What is the mean optical power launched into an 8km length fiber is 120MW, the mean optical power at the fiber output is 3µW. Determine  (1)Overall signal attenuation in dB/km and  (2)The overall signal attenuation for a 10km optical link using the same fiber With splices at 1km intervals, each giving an attenuation of 1dB. | CO2 |
| 4.With diagram, explain intra and inter modal dispersion | CO3 |

|  |  |
| --- | --- |
| 5.Explain the step involved in splicing the fiber. Discuss the various splicing techniques employed between two fibers. | CO4 |
| 6.Draw the structures of PIN and APD photo detectors and explain their operations.( | CO4 |

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| --- | --- |
| 7.What are the non- linear effects on network performance? Explain them briefly. | CO5 |

**Part C** (30 Marks)

|  |  |
| --- | --- |
| 1.What are the various features of graded index fiber? Explain the refractive index profile and ray transmission in a multimode graded index fiber | CO1 |
| 1. 2. Explain the following with necessary diagram and expressio ns 2. (i) Non linear scattering loss and fiber bend loss. 3. (ii) Material dispersion in optical fiber. | CO2 |
| 3.The quantum efficiency of a particular silicion RAPD is 80% for the detection of radiation at a wavelength of 0.9 µm, when the incident optical power is 0.5 µW.The output current from the device(after avalanche gain) is 11µA.Determine the multiplication factor of the photodiode under these conditions | CO3 |
| 4. A silicon p- i-n photodiode incorporated into an optical receiver has a quantum efficiency of 60% when operating at a wavelength of 0.9mm. The dark current is 3 nA and the load resistance is 4 KΩ. The incident optical power is 200 nW and the post detection bandwidth of the receiver is 5 MHZ. Calculate the root mean square (rms) shot noise and thermal noise currents generated. | CO4 |
| 5.Explain the following requirements for the design of an optically amplified WDM link: i) Link Bandwidth  ii) Optical power requirements for a specific BER | CO5 |

**STUDENT PERFORMANCE REPORT**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **ROLL NO.** | **NAME** | **I-MID** | **II-MID** | **AVG** | **ASSIGNMENT** | **OUT OF MARKS 50** |
| 21ETCEC001 | Abbas Hakimuddim Fakhruddin | 22 | 22 | 22 | 15 | 37 |
| 21ETCEC002 | Abhishek Kalal | 26 | 22 | 24 | 17 | 41 |
| 21ETCEC003 | Abhishek Rajwaniya | 24 | 28 | 26 | 17 | 43 |
| 21ETCEC004 | Alfez Umar Sheikh | 29 | 26 | 28 | 16 | 44 |
| 21ETCEC005 | Dhawal Purohit | 24 | 24 | 24 | 19 | 43 |
| 21ETCEC006 | Ms Himanshi Soni | 28 | 26 | 27 | 20 | 47 |
| 21ETCEC007 | Jalal Dashora | 25 | 28 | 27 | 20 | 47 |
| 21ETCEC008 | Jatin Tailor | 27 | 29 | 28 | 19 | 47 |
| 21ETCEC009 | Manav Kumawat | 30 | 30 | 30 | 20 | 50 |
| 21ETCEC010 | Mohit Gour | 26 | 23 | 25 | 18 | 43 |
| 21ETCEC013 | Rachit Dutt | 29 | 25 | 27 | 19 | 46 |
| 21ETCEC014 | Sanidhya Sharma | 25 | 25 | 25 | 19 | 44 |
| 21ETCEC016 | Shoaib Khan Pathan | 25 | 25 | 25 | 19 | 44 |
| 21ETCEC017 | Snehil Sharma | 27 | 27 | 27 | 19 | 46 |
| 21ETCEC018 | Sumit Israni | 27 | 22 | 25 | 16 | 41 |
| 21ETCEC019 | Yuvraj Nagda | 23 | 27 | 25 | 20 | 45 |
| 21ETCEC300 | Sahil Bhoi | 23 | 23 | 23 | 20 | 43 |
| 22ETCEC200 | Khushwant Singh | 25 | 27 | 26 | 18 | 44 |

**Signature of Faculty: Signature of HOD**

**RESULT ANALYSIS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.NO.** | **RTU ROLL NUMBER** | **NAME OF STUDENT** | **END TERM MARKS** | **SESSIONAL MARKS** | **TOTAL** |
|  |  |  | **70** | **30** | **100** |
|  |  | **Set Target Level** | **60%** | **75%** |  |
| **1** | 21ETCEC001 | Abbas Hakimuddim Fakhruddin | A | 22 | 22 |
| **2** | 21ETCEC002 | Abhishek Kalal | 39 | 24 | 63 |
| **3** | 21ETCEC003 | Abhishek Rajwaniya | 32 | 26 | 58 |
| **4** | 21ETCEC004 | Alfez Umar Sheikh | 38 | 28 | 66 |
| **5** | 21ETCEC005 | Dhawal Purohit | 41 | 24 | 65 |
| **6** | 21ETCEC006 | Ms Himanshi Soni | 32 | 27 | 59 |
| **7** | 21ETCEC007 | Jalal Dashora | 30 | 27 | 57 |
| **8** | 21ETCEC008 | Jatin Tailor | 37 | 28 | 65 |
| **9** | 21ETCEC009 | Manav Kumawat | 48 | 30 | 78 |
| **10** | 21ETCEC010 | Mohit Gour | 43 | 25 | 68 |
| **11** | 21ETCEC013 | Rachit Dutt | 33 | 27 | 60 |
| **12** | 21ETCEC014 | Sanidhya Sharma | 35 | 25 | 60 |
| **13** | 21ETCEC016 | Shoaib Khan Pathan | 33 | 25 | 58 |
| **14** | 21ETCEC017 | Snehil Sharma | 32 | 27 | 59 |
| **15** | 21ETCEC018 | Sumit Israni | 40 | 25 | 65 |
| **16** | 21ETCEC019 | Yuvraj Nagda | 31 | 25 | 56 |
| **17** | 21ETCEC300 | Sahil Bhoi | 37 | 30 | 67 |
| **18** | 22ETCEC200 | Khushwant Singh | 35 | 26 | 61 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| TOTAL | PASS | FAIL | ABSENT | PASS % |
| 18 | 17 | 1 | 1 | 94.4 |

**Indirect Assessment:**

**Overall Teacher Self Assessment (at the completion of course) in terms of course objective and outcomes**

**Course Objectives:**

Student will learn fundamentals of Fiber optic communication from this 40-hour course. In this course, student will study the fundamental concepts and application of optical communication. They will study different optical measurement like noise analysis, attenuation signal degradation calculation etc. using devices like OTDR. Also, they will be able to design the different optical devices like sources, detectors and amplifiers.

**Course Outcomes**:

Explain basic knowledge of Ray theory principle & optical fibber working concepts.

The knowledge of optical communication subject helps the students to perform various experiments in laboratories which will help in understanding theory more clearly.

Analyze the use of modern upcoming technologies in optical communication.

Design tools for optical system design, test and evaluation

Evaluate the performance of optical components.

**Methodology to identify bright student**

Considered a range of criteria, including academic performance, creativity, critical thinking, problem-solving skills, and enthusiasm for learning. Bright students often excel in multiple areas. Observed how students perform in the classroom. In terms of active participation, engagement in discussions, leadership, and the ability to grasp complex concepts.

**Efforts to keep students engaged**

1. Active Learning:
   * Incorporate active learning strategies, such as group discussions, problem-solving activities, and hands-on projects. Active participation keeps students engaged and encourages critical thinking.
2. Varied Teaching Methods:
   * Use a variety of teaching methods, including lectures, group work, multimedia presentations, and interactive activities to cater to different learning preferences.
3. Technology Integration:
   * Leverage technology, such as online platforms, educational apps, and interactive software, to make lessons more engaging and interactive.

Some extra learning for bright students

1. <https://nptel.ac.in/courses/108/106/108106167/>
2. <https://www.coursera.org/specializations/waves-optics>

**Methodology to identify weakstudent**

Considered a range of criteria, including classroom observation, formative assessment, summative assessment, assignment review e.t.c. Weak students are struggling students with sensitivity and a desire to support their learning. Some measures, such as additional tutoring, personalized assignments, or alternative assessment methods, to help students succeed.

**Targeted inventions for weak student**

**1. Additional Resources**

Offer supplementary learning materials, such as textbooks, online resources, or multimedia content, to provide alternative explanations and reinforce key concepts.

**2. Remedial classes**

Establish a tutoring program where students can receive extra help from teachers.

**3. Flipped classroom**

Students are assigned pre-class learning materials, often in the form of videos, readings, or online modules, to cover the foundational concepts before coming to class.

Some additional resources or links for student to improve their understanding for topic

1. <https://archive.nptel.ac.in/courses/115/107/115107095/>
2. <https://www.coursera.org/specializations/waves-optics>
3. <https://www.sanfoundry.com/optical-communication-questions-answers-optical-fibers/>