**COURSE OUTCOMES:** Students are able to

CO1: Summarize the field components and analyze different modes in waveguide. **[K2]**

CO2: Interpret different microwave components and devices. **[K2]**.

CO3: Experiment with microwave measurements through bench setup. **[K3]**

CO4: Classify different types of Optical fibers. **[K4]**.

CO5: Categorize the optical sources, optical detectors and explain digital receiver **[K4]**

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| Unit No | | Outcome | Topics/Activity | | Ref Text book | Total Periods | Delivery Method | | | | | |
| 1 | | CO1: Summarize the field components and analyze different modes in waveguide. **[K2]** | **Unit-1: MICROWAVE TRANSMISSION LINES** | | | |  | | | | | |
| 1.1 | Introduction, Microwave Spectrum and Bands | T1, R1,R4 | 10 | | Chalk & Talk, PPT,  & Tutorial | | | | |
| 1.2 | Applications of Microwaves. Rectangular Waveguides – TE | T1, R1,R4 | Chalk & Talk, PPT, | | | | |
| 1.3 | TM mode analysis, Expressions for Fields, Dominant and Degenerate Modes, | T1, R1,R4 | & Tutorial | | | | |
| 1.4 | Introduction to Circular wave guides, related problems | T1, R1,R4 | Chalk & Talk, PPT, | | | | |
| 2 | | CO2: Interpret different microwave components and devices. **[K2]**. | **Unit-2: MICROWAVE COMPONENTS & MICROWAVE TUBES** | | | |  | | | | | |
| 2.1 | Waveguide Attenuators – Resistive Card and Rotary Vane types | T1, R1,R4 | 10 | | | Chalk & Talk, PPT,  & Tutorial | | | |
| 2.2 | Calculation of scattering matrix for E plane, H plane, Magic Tee and Directional Coupler | T1, R1,R4 | Chalk & Talk, PPT, | | | |
| 2.3 | Ferrite Components – Gyrator, Isolator,Circulator. Classification of Microwave Tubes, Two Cavity Klystron – Structure | T1, R1,R4 | & Tutorial | | | |
| 2.4 | Velocity Modulation Equation, Applegate Diagram; Reflex Klystron – Structure | T1, R1,R4 | Chalk & Talk, PPT, | | | |
| 2.5 | Applegate Diagram; Travelling Wave Tube – operation, Magnetron operation. | T1, R1,R4 | & Tutorial | | | |
| 3 | | CO3: Experiment with microwave measurements through bench setup. **[K3]** | **Unit-3: MICROWAVE SOLID STATE DEVICES & MEASUREMENTS (10)** | | | |  | | | | | |
| 3.2 | Description of Microwave Bench, Measurement of Attenuation, Frequency | T1, R1,R4 | 10l | | | | Chalk & Talk, PPT,  & Tutorial | | |
| 3.3 | VSWR using Microwave Bench and Power measurement. | T1, R1,R4 | Chalk & Talk, PPT, & Tutorial | | |
| 3.4 | Bolometer Method. | T1, R1,R4 | Chalk & Talk, PPT, & Tutorial | | |
| 3.5 | IMPATT Diode | T1, R1,R4 | Chalk & Talk, PPT, | | |
| MID I EXAMINATION DURING 9th WEEK | | | | | | | | | | | | |
| 4 | | CO4: Classify different types of Optical fibers. **[K4]**. | **Unit-4:** **Overview of optical fiber communication** | | | |  | | | | | |
| 4.1 | Historical development, the general system, advantages of optical fiber communications | T2, R3 | 10 | | | | | Chalk & Talk, PPT,  & Tutorial | |
| 4.2 | Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection | T2, R3 | Chalk & Talk, PPT, & Tutorial | |
| 4.3 | Acceptance angle, Numerical Aperture, Types of rays, V-number | T2, R3 | Chalk & Talk, PPT, & Tutorial | |
| 4.4 | Mode coupling, Step Index fibers, Graded Index fibers | T2, R3 | Chalk & Talk, PPT, & Tutorial | |
| 4.5 | Single mode fibers- Cut off wavelength, Mode Field Diameter, Related problems. | T2, R3 | Chalk & Talk, PPT, & Tutorial | |
| 5 | | CO5: Categorize the optical sources, optical detectors and explain digital receiver **[K4]** | **Unit-5:** **Optical Sources and Optical Detectors** | | | |  | | | | | |
| 5.1 | Structures, quantum efficiency | T2, R3 | 10 | Chalk & Talk, PPT,  & Tutorial | | | | | |
| 5.2 | modulation; Laser diodes principle ,modes, threshold conditions | T2, R3 | Chalk & Talk, PPT,  & Tutorial | | | | | |
| 5.3 | External quantum efficiency, resonant frequencies, Reliability of LED&ILD. | T2, R3 | Chalk & Talk, PPT,  & Tutorial | | | | | |
| 5.4 | Principle, PIN and avalanche photo diodes; comparison of photo detectors | T2, R3 | 8 | Chalk & Talk, PPT,  & Tutorial | | | | | |
| 5.5 | Temperature effect on avalanche gain | T2, R3 | Chalk & Talk, PPT, | | | | | |
| 5.6 | noise in photo detectorsOpticalreceiveroperation-Fundamentalreceiveroperation | T2, R3 | & Tutorial | | | | | |
| 5.7 | Digital signal transmission,errorsources,performance Receiverconfiguration,Digitalreceiver | T2, R3 | Chalk & Talk, PPT, | | | | | |
| 5.8 | Probability of Error Optical system design-Point-to-point links-Component choice and considerations, Link power budget, Rise time budget with examples. | T2, R3 | & Tutorial | | | | | |
| Total | 58 |  | | | | | |
| MID II EXAMINATION DURING 18th WEEK | | | | | | | | | | | | |
| END EXAMINATIONS | | | | | | | | | | | | |
| **Text Books:** | | | | | | | | | | | | |
| T1 | | Samuel Y. Liao, “Microwave Devices and Circuits”, PHI, 3rd Edition, 1994. | | | | | | | | | | |
| T2 | | Gerd Keiser, “Optical fiber communications “,3rd  ed.,MGH. (Units -IV to VI). | | | | | | | | | | |
| **Reference Books:** | | | | | | | | | | | | |
| R1 | | R.E. Collin, “Foundations for Microwave Engineering”, IEEE Press, John Wiley, 2 nd Edition, 2002. | | | | | | | | | | |
| R2 | | Herbert J. Reich, J.G. Skalnik, P.F. Ordung and H.L. Krauss, “Microwave Principles”, CBS Publishers and Distributors, New Delhi, 2004. | | | | | | | | | | |
| R3 | | Djafar K. Mynbaev and Lowell L. Scheiner, “Fiber Optic Communication Technology”, Pearson Education Asia. | | | | | | | | | | |
| R4 | | M*.*Kulkarni, *“*Microwave and Radar Engineering*”* ,Umesh Publications, New Delhi. 3rd Edition. | | | | | | | | | | |

**Principal HOD Faculty**