# Detailed Syllabus
## Lecture-wise Breakup

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|---|---|---|---|
| **Course Code** | 18M12EC115 | **Semester** ODD **(specify Odd/Even)** | **Semester** ODD **Session** 2020 - 2021 **Month from** July - December |
| **Course Name** | Advanced Optical Communication Systems | | |
| **Credits** | 3 | **Contact Hours** | 3 |

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|---|---|---|
| **Faculty (Names)** | **Coordinator(s)** | |
| | **Teacher(s) (Alphabetically)** | |

| **COURSE OUTCOMES** | | **COGNITIVE LEVELS** |
|---|---|---|
| **CO1** | Develop an understanding of optical fiber, its structure, types, propagation, transmission and non-linear properties. | Remembering (C1) |
| **CO2** | Identify and examine the different kinds of losses and signal distortion along with their compensation techniques in optical Fibers. | Analyzing (C4) |
| **CO3** | Classify the Optical sources and detectors and their principle of operation and analyze different coupling techniques. | Understanding (C2) |
| **CO4** | Design short haul and long haul Analog/ Digital optical communication system with an insight into advanced optical systems. | Evaluating (C5) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | Overview of Optical fiber Communications | Introduction to fiber optics, Physics of light. Principles of fiber optics: Introduction, light propagation, Skew rays. TIR condition, FTIR, Goos-hanchen shift. Effective index method to determine propagation constant, Fibers Modes, V Number analysis for optical fiber, Significance of V-b diagram, Mode Coupling, Step Index fibers, Graded Index fibers. Single mode fibers- Cut off wavelength, line width, propagation velocities. Non-linear effects in optical fiber | 7 |
| **2.** | Signal Degradation in Optical fibers | Signal distortion in optical fibers- Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses. Information capacity, Group delay, Types of Dispersion - Material dispersion, Wave- | 7 |

| | | | |
|---|---|---|---|
| | | guide dispersion, Intermodal dispersion, Fiber Birefringence, Polarization Mode Dispersion. Introduction to Dispersion compensation techniques, Advanced chromatic dispersion compensation, Advanced PMD compensation (both optical and electrical). | |
| **3.** | Optical Sources | Light emitting diode (LEDs)- structures designing and performance analysis, Quantum efficiency, Power, Modulation, Laser Diodes -Modes & threshold conditions, resonant frequencies, structures, characteristics single mode lasers, Modulation of laser diodes, external quantum efficiency, laser diode rate equations. Source to fiber power launching: - Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Various fiber to light coupling techniques, Laser diode to fiber coupling, LED coupling to single mode fiber. | 8 |
| **4.** | Photodetectors & Receivers | Optical detectors- principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Optical receiver: Fundamental receiver operation, Digital signal transmission, error sources, Receiver configuration, Digital receiver performance, Probability of error, Quantum limit, Analog receivers. | 8 |
| **5.** | Optical system design | Optical Amplification, Doped fiber amplifier, semiconductor optical amplifier, Analog and digital systems. Coherent optical fiber communication systems. Modulation and line coding. Bandwidth and rise time budgets, Power budget, and dynamic range. Power penalty, Channel capacity measurement. | 6 |
| **6.** | Advanced Optical Systems and Networks | Wavelength Division Multiplexing. Long haul and metro WDM system, WDM system analysis, design and performance evaluation, Introduction to Photonic crystal technology, Photonic crystal fibers, Introduction to Optical Networks, Local area network, Metropolitan-Area N/W,SONET/SDH, Introduction to Free Space optical Communication. | 8 |
| **7.** | | | |
| | | **Total number of Lectures** | **44** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25 |
| **Total** | **100** |

| **Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format) | |
|---|---|
| **1.** | Gerd Keiser, Optical Fiber Communications, 3rd Edition, McGraw-Hill International edition, 2000. |
| **2.** | John M. Senior, Optical Fiber Communications, 2nd Edition, PHI, 2002. |
| **3.** | D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Fiber Optic Communications, Pearson Education, 2005. |
| **4.** | Govind P. Agarwal, Fiber Optic Communication Systems, 3rd Edition, John Wiley, 2004. |
| **5.** | Joseph C. Palais, Fiber Optic Communications, 4th Edition, Pearson Education, 2004 |
| **6.** | Journal articles i.e. IEEE, Springer, IOPscience, Elsevier and Video lectures from nanohub, NPTEL, MIT video lectures |

# Detailed Syllabus

## Lecture-wise Breakup

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|---|---|---|---|
| **Subject Code** | 20M11EC111 | **Semester: ODD** | **Semester: I Session: 2020-2021**<br>**Month from** July **to** December |
| **Subject Name** | Advanced RF and Microwave Engineering | | |
| **Credits** | 3 | **Contact Hours** | 3 |
| **Faculty (Names)** | **Coordinator(s)** | Dr. Jasmine Saini | |
| | **Teacher(s) (Alphabetically)** | Dr. Jasmine Saini | |

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|---|---|---|
| **COURSE OUTCOMES-** At the completion of the course, students will be able to | | **COGNITIVE LEVELS** |
| CO1 | Develop an understanding of concepts of microwave circuits and ISM applications. | Understanding (Level II) |
| CO2 | Explain the concepts of microwave circuits and scattering parameters. | Evaluating (Level V) |
| CO3 | Design and analyze impedance transformers. | Analyzing (Level IV) |
| CO4 | Design and apply microwave components like dividers, filters,resonators etc. in Microwave systems. | Applying (Level III) |

| **Module No.** | **Title of the Module** | **Topics in the module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | Transmission Lines and Waveguides | Review of Microwave Engineering; Advantages, disadvantages and ISM applications of microwaves; TEM mode transmission lines: lossless line, line with small losses; Quasi TEM mode lines: Fields in micro striplines and striplines, losses in microstrips, microstrip discontinuities, coupled lines, slot lines and coplanar waveguides; Wave velocities. | 8 |
| **2.** | Microwave Circuit Theory Principles | Equivalent voltages and currents; Z, Y, S, and ABCD parameters; Equivalent circuit representation of microwave junctions; | 10 |

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|---|---|---|---|
| | | Scattering parameter analysis of microwave junctions. | |
| **3.** | Impedance Transformers | Review of single-, double- and triple-stub tuners; waveguide reactive elements; quarter-wave transformers; design of maximally flat and Chebyshev transformers; Introduction to tapered transmission lines. | 6 |
| **4.** | Power Dividers and Couplers | Scattering matrix of 3- and 4-port junctions; Design of T-junction and Wilkinson power dividers; Design of 90 and 180 hybrids. | 6 |
| **5.** | Filters | Analysis of periodic structures; Floquet's theorem; filter design by insertion loss method; maximally flat and Chebyshev designs. | 6 |
| | Resonators | Principles of microwave resonators; loaded, unloaded and external Q, open and shorted TEM lines as resonators; microstrip resonators; dielectric resonators. | 6 |
| | | Total number of Lectures | **42** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25(Attendance, Performance. Assignment/Quiz) |
| **Total** | **100** |

**Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)


| | |
|---|---|
| **1.** | Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley & Sons,2000. |
| **2.** | Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Sons,2004. |

| | |
|---|---|
| **3.** | Edwards, T.C. and Steer M.B., “Foundations for Interconnects and Microstrip Design”, 3rd Ed., John Wiley & Sons.,2001. |
| **4.** | Ludwig, R. and Bretchko, P., “RF Circuit Design”, Pearson Education,2000. |
| **5.** | Hunter, I., “Theory and Design of Microwave Filters”, IEE Press,2001. |
| **6.** | Misra, D.K., “Radio-frequency and Microwave Communication Circuits”, John Wiley & Sons,2001. |
| **9.** | https://nptel.ac.in/courses/108/101/108101112/ |

# Detailed Syllabii

## Lecture-wise Breakup

| Subject Code | 17M11EC119 | Semester<br>Odd | Semester 1 Session 2020 - 21<br>Month from July to December |
|---|---|---|---|
| Subject Name | Advanced Wireless and Mobile Communications | | |
| Credits | 03 | Contact Hours | 03 |

| Faculty (Names) | Coordinator(s) | 1. Pankaj Kr. Yadav |
|---|---|---|
| | Teacher(s) (Alphabetically) | 1. Pankaj Kr. Yadav |

| COURSE OUTCOMES | | COGNITIVE LEVELS |
|---|---|---|
| CO1 | To review wireless and mobile communication, Cellular Concept | (Level I) |
| CO2 | To understand the concept of Propagation of Mobile Radio Signals | (Level II) |
| CO3 | To analyze the FDMA, TDMA, CDMA, OFDMA techniques wireless and mobile communication | (Level III) |
| CO4 | To evaluate GSM, UMTS and LTE Air Interface | (Level IV) |

| Module No. | Subtitle of the Module | Topics in Module | No. of Lectures |
|---|---|---|---|
| 1. | Introduction | Introduction to the wireless communications. Its relevance. Overview. Coverage- syllabi. Recommended reading. Evaluation Scheme. | 4 |
| 2. | Cellular Concept and Engineering | Problems in mobile communication. Need for Cells. Spectrum and its utilization – frequency reuse. Cell design considerations. Cell Topology. Co-channel and adjacent – channel cells interference. Cell splitting and sectoring. Coverage and capacity of cellular system. Hand-off techniques. | 8 |
| 3. | Propagation of Mobile Radio Signals | Radio wave propagation mechanism. Path loss .Outdoor and Indoor propagation models. Antenna types, size and height. Multipath propagation model .Different types of fading. Doppler effect and mobility. | 6 |
| 4. | Multiple Access Techniques | FDMA, TDMA, CDMA, OFDMA techniques and their performance. Number of channels. | 2 |
| 5. | OFDM in LTE | Introduction of Orthogonal Frequency Division Multiplexing, OFDM in LTE | 4 |
| 6. | LTE Radio Access Networks | LTE RADIO INTERFACE; Logical, Transport and physical Channels; Reference Signals, Physical Cell ID, Time-Domain Structure, Scheduling in LTE | 12 |

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|---|---|---|---|
| **7.** | LTE Advancecd and 5G RAN | Introduction of LTE-Advanced and 5G RAN; and Recent developments. | 4 |
| | | **Total number of Lectures** | 40 |

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|---|---|
| **Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format) | |
| 1. | T. S. Rappaport, Wireless Communications, PHI, 2002. |
| 2. | Gunnar Heine, GSM Networks: Protocols, Terminology and Implementation, Artech House, 1999. |
| 3. | Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005 |
| 4. | Harri Holma, Antti Toskala, LTE for UMTS: Evolution to LTE-Advanced, John Wiley and Sons, 2011 |
| 5. | 5G Technology Evolution Recommendations, 4G Americas, 2015 |
| 6 | http://www.3gpp.org/ftp/Specs/html-info/36-series.htm |

# Detailed Syllabus

## Lecture-wise Breakup

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|---|---|---|---|
| **Subject Code** | 16M3NEC361 | **Semester: Even (specify Odd/Even)** | **Semester** 10th **Session** 2019- 20<br>**Month from** July 19 **to** Dec 19 |
| **Subject Name** | Estimation over Distributed Networks | | |
| **Credits** | 3 | **Contact Hours** | 3 |

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| **Faculty (Names)** | | **Coordinator(s)** | 1. Vikram Karwal |
| | | **Teacher(s) (Alphabetically)** | Vikram Karwal |

| S.No | Course Outcome | Cognitive levels/Blooms taxonomy |
|---|---|---|
| C121.1 | To course aims to familiarize students with the importance of distributed adaptation, optimization and learning by multi-agent systems over distributed networks | Understanding Level (C2) |
| C121.2 | The course aims to help student analyze efficient processing of Massive data using Distributed Networks. | Analyzing Level (C4) |
| C121.3 | The course helps students understand, Importance and Need of distributed Networks. | Analyzing Level (C4) |
| C121.4 | The course helps students to analyze local information available at individual nodes in a distributed manner. | Applying Level (C3) |
| C121.5 | The students will be able to compute the computational complexity and compare various distributed algorithms. | Evaluating Level (C5) |

| Module No. | Subtitle of the Module | Topics in the module | No. of Lectures for the module |
|---|---|---|---|
| **1.** | Introduction and Background Material | Important matrix and Linear Algebra results, Convexity criterion, computation of complex Gradients and Hessian, Lipschitz conditions, regression, log-logistic cost function, mean-value theorems | 6 |

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|---|---|---|---|
| **2.** | Single-Agent Adaptation and Learning | Stochastic-gradient optimization, convergence and stability properties, constant and variable step size conditions, Mean-square error performance | 6 |
| **3.** | Centralized Adaptation and Learning | Batch and centralized processing, convergence, stability and performance | 5 |
| **4.** | Multi-Agent Network Model | Importance of Distributed Networks vs. Centralized processing, distributed adaptation over networks, distributed learning over networks, optimization over distributed networks, importance of localized interactions among agents, their applications in social networks, biological networks. | 9 |
| **5** | Stability & Performance | Performance analysis of various estimation algorithms their convergence analysis, learning curves and their stability, robustness and resilience to failure, privacy and secrecy considerations among agents. | 8 |
| **6.** | Advanced Network Topologies | Benefits of co-operation, combination strategies, Role of Informed Agents, Adaptive Combination strategies, Asynchronous strategies, clustering | 6 |
| | | | **Total number of Lectures** | 40 |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25 |
| **Total** | **100** |

| **Recommended Reading material:** | |
|---|---|
| **1.** | A. H. Sayed, *Adaptation, Learning, and Optimization over Networks,* NOW Publishers, 2014. |
| **2.** | S. Boyd, L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004. |

| | |
|---|---|
| **3.** | T. Kailath, A. H. Sayed, B. Hassibi, Linear Estimation, Prentice Hall, 2000 |

# Detailed Syllabus
## Lecture-wise Breakup

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|---|---|---|---|
| **Course Code** | XXXXX | **Semester:** Even<br>**(specify Odd/Even)** | **Session: 2020-2021**<br>**Month from: Jan -June** |
| **Course Name** | Millimeter wave technology | | |
| **Credits** | 3 | **Contact Hours** | 3 |
| **Faculty (Names)** | **Coordinator(s)** | Dr. Neetu Joshi | |
| | **Teacher(s) (Alphabetically)** | Dr. Neetu Joshi | |

| **COURSE OUTCOMES-** At the completion of the course, students will be able to | | **COGNITIVE LEVELS** |
|---|---|---|
| **CO1** | Understand the millimetre-wave and microwave planar transmission lines (microstrip and CPW), their classification, basic properties, field distribution and range of applications. | Understanding Level (C2) |
| **CO2** | Analyze the dielectric integrated guides and use of effective dielectric constant in the approximate analysis of dielectric guide. | Analyzing Level (C4) |
| **CO3** | Analyze the behaviour of Composite Right/Left Handed (CRLH) transmission line metamaterials. | Analyzing Level (C4) |
| **CO4** | Design and analyse RF behaviour of passive elements such as filters, resonators, couplers and splitters using lumped and distributed element models. | Analyzing Level (C4) |
| **CO5** | Design and analyse active devices such as amplifiers and oscillators using planar and non-planar transmission lines. | Analyzing Level (C4) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | Fundamental Concepts | Elements of microwave/millimeter wave integrated circuits; Classification of transmission lines: Planar, quasiplanar and 3-D structures, their basic properties, field distribution and range of applications; Substrate materials and technology used for fabrication. | 5 |
| **2.** | Analysis of Planar Transmission Lines | Variational approach for the determination of capacitance of planar structures; Transverse transmission line techniques for multi-dielectric planar structures; Rigorous analysis of dielectric integrated guides; Use of effective dielectric constant in the approximate analysis of dielectric guide. | 12 |
| **3.** | Metamaterials | Theory of Composite Right/Left Handed (CRLH) transmission line metamaterials; Representation of CRLH metamaterial by an equivalent homogeneous CRLH TL; L- | 6 |

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|---|---|---|---|
| | | C network implementation and its physical realization. | |
| **4.** | Discontinuities | Analysis of discontinuities in planar and non-planar transmission lines and their equivalent circuit representation. | 5 |
| **5.** | Passive Circuits | Design and circuit realization of filters, couplers, phase shifters, and switches using planar and non-planar transmission lines. | 8 |
| **6.** | Active Circuits | Design and circuit realization of amplifiers and oscillators using planar and non-planar transmission lines. | 6 |
| | | **Total number of Lectures** | **42** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25(Attendance, Performance. Assignment/Quiz) |
| **Total** | **100** |

**Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)


| | |
|---|---|
| **1.** | Edwards, T.C. and Steer M.B., “Foundations for Interconnects and Microstrip Design”, 3rd Ed., John Wiley & Sons, 2001. |
| **2.** | Wolf, I., “Coplanar Microwave Integrated Circuits”, John Wiley & Sons, 2006. |
| **3.** | Bhat, B. and Koul, S.K., “Stripline Like Transmission Lines”, John Wiley & Sons, 1989. |
| **4.** | Caloz, C. and Itoh, T., “Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications”, Wiley IEEE Press, 2005. |
| **5.** | Bhat, B. and Koul, S. K., “Analysis, Design and Applications of Finlines”, Artech House, 1987. |
| **6.** | Koul, S.K., “Millimeter Wave and Optical Dielectric Integrated Guides and Circuits”, John Wiley & Sons, 1997. |
| **7.** | Ludwig, R. and Bretchko, P., “RF Circuit Design”, Pearson Education, 2000. |

# <u>Detailed Syllabus</u>
# Lecture-wise Breakup

| | | | | |
|---|---|---|---|---|
| **Course Code** | XXXXX | | **Semester:** Even<br>**(specify Odd/Even)** | **Session: 2020-2021**<br>**Month from: Jan -June** |
| **Course Name** | Millimeter wave technology | | | |
| **Credits** | 3 | | **Contact Hours** | 3 |
| **Faculty (Names)** | **Coordinator(s)** | Dr. Neetu Joshi | | |
| | **Teacher(s) (Alphabetically)** | Dr. Neetu Joshi | | |

| **COURSE OUTCOMES-** At the completion of the course, students will be able to | | **COGNITIVE LEVELS** |
|---|---|---|
| **CO1** | Understand the millimetre-wave and microwave planar transmission lines (microstrip and CPW), their classification, basic properties, field distribution and range of applications. | Understanding Level (C2) |
| **CO2** | Analyze the dielectric integrated guides and use of effective dielectric constant in the approximate analysis of dielectric guide. | Analyzing Level (C4) |
| **CO3** | Analyze the behaviour of Composite Right/Left Handed (CRLH) transmission line metamaterials. | Analyzing Level (C4) |
| **CO4** | Design and analyse RF behaviour of passive elements such as filters, resonators, couplers and splitters using lumped and distributed element models. | Analyzing Level (C4) |
| **CO5** | Design and analyse active devices such as amplifiers and oscillators using planar and non-planar transmission lines. | Analyzing Level (C4) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | Fundamental Concepts | Elements of microwave/millimeter wave integrated circuits; Classification of transmission lines: Planar, quasiplanar and 3-D structures, their basic properties, field distribution and range of applications; Substrate materials and technology used for fabrication. | 5 |
| **2.** | Analysis of Planar Transmission Lines | Variational approach for the determination of capacitance of planar structures; Transverse transmission line techniques for multi-dielectric planar structures; Rigorous analysis of dielectric integrated guides; Use of effective dielectric constant in the approximate analysis of dielectric guide. | 12 |
| **3.** | Metamaterials | Theory of Composite Right/Left Handed (CRLH) transmission line metamaterials; Representation of CRLH metamaterial by an equivalent homogeneous CRLH TL; L- | 6 |

| | | | |
|---|---|---|---|
| | | C network implementation and its physical realization. | |
| **4.** | Discontinuities | Analysis of discontinuities in planar and non-planar transmission lines and their equivalent circuit representation. | 5 |
| **5.** | Passive Circuits | Design and circuit realization of filters, couplers, phase shifters, and switches using planar and non-planar transmission lines. | 8 |
| **6.** | Active Circuits | Design and circuit realization of amplifiers and oscillators using planar and non-planar transmission lines. | 6 |
| | | **Total number of Lectures** | **42** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25(Attendance, Performance. Assignment/Quiz) |
| **Total** | **100** |

**Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)


| | |
|---|---|
| **1.** | Edwards, T.C. and Steer M.B., "Foundations for Interconnects and Microstrip Design", 3rd Ed., John Wiley & Sons, 2001. |
| **2.** | Wolf, I., "Coplanar Microwave Integrated Circuits", John Wiley & Sons, 2006. |
| **3.** | Bhat, B. and Koul, S.K., "Stripline Like Transmission Lines", John Wiley & Sons, 1989. |
| **4.** | Caloz, C. and Itoh, T., "Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications", Wiley IEEE Press, 2005. |
| **5.** | Bhat, B. and Koul, S. K., "Analysis, Design and Applications of Finlines", Artech House, 1987. |
| **6.** | Koul, S.K., "Millimeter Wave and Optical Dielectric Integrated Guides and Circuits", John Wiley & Sons, 1997. |
| **7.** | Ludwig, R. and Bretchko, P., "RF Circuit Design", Pearson Education, 2000. |

# Detailed Syllabus

## Lecture-wise Breakup

| | | | |
|---|---|---|---|
| **Subject Code** | 17M21EC112 | **Semester: ODD** | **Semester: I Session: 2020-2021**<br>**Month from** July **to** December |
| **Subject Name** | Photonics Materials & Devices for Communications | | |
| **Credits** | 4 | **Contact Hours** | 3-1-0 |

| | | |
|---|---|---|
| **Faculty (Names)** | **Coordinator(s)** | Dr. Amit Kumar Goyal |
| | **Teacher(s) (Alphabetically)** | Dr. Amit Kumar Goyal |

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|---|---|---|
| **COURSE OUTCOMES-** At the completion of the course, students will be able to | | **COGNITIVE LEVELS** |
| **CO1** | Develop an understanding of photonic components and optical fiber technology. | Understanding (Level II) |
| **CO2** | Design and analyze different types of Photonic/Nano-photonic devices and components. | Applying (Level III) |
| **CO3** | Classify the material system/technologies along with their fabrication processes to design efficient photonic devices for communication. | Analyzing (Level IV) |
| **CO4** | Analytically evaluate the various photonic devices. | Evaluating (Level V) |

| **Module No.** | **Title of the Module** | **Topics in the module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | Basics of Photonics, Optical fibers and | Photonics, integrated photonics and their brief history, Basic photonic technologies and components, Brief introduction to Maxwell's equations, wave equation, Electromagnetic waves at different dielectric interfaces.<br><br>Overview of Optical fibers, types (step-index and graded index), single-mode and multi-mode along with their condition, birefringent | 10 |

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|---|---|---|---|
| | | fiber, numerical aperture, Optical fiber communications, Dispersion and scattering losses in fiber, budget analysis. | |
| **2.** | Optical waveguides and Photonic Devices | Optical waveguides classification, Guided modes in optical waveguides, Dispersion of guided modes, Single-mode 3-D optical waveguides. Basic integrated-optic devices: Optical power splitter, Directional coupler, thermo-optic switches, Mach-Zehnder interferometer, Arrayed Waveguide Grating (AWG)-based MUX/DEMUX, Add-drop multiplexer, Design of photonic devices: Beam Propagation Method and Marcatili's Method. | 10 |
| **3.** | Fundamental of Nano-Photonic Devices and Components | Nano-photonics: Photonic crystal (PhC) technology, PhC waveguide, PhC resonator, PhC MUX/DEMUX, PhC Filters, PhC fibers, Nano-wires, Packaging of photonic devices. Recent studies on PhC based devices for communication applications. | 6 |
| **4.** | Photonic Materials and Fabrication Technologies | Photonic materials, selection of materials like silicon, silica, Lithium Niobate, Compound Semiconductor and Polymers. Fabrication and process techniques like Lithography, Deposition, and Diffusion etc. Parameter measurement and techniques, recent studies on photonic materials. | 10 |
| **5.** | Coupled-mode Theory and Devices | Basic concepts of coupled mode theory, Mode coupling: co-directional and contra-directional, Mode coupling in corrugated waveguides, Short-period and long-period gratings in optical fibers and optical waveguides, Properties of short-period and long-period gratings, Application of gratings in communication, and Recent trends. | 8 |
| | | Total number of Lectures | **44** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25(Attendance, Performance. Assignment/Quiz) |

| | |
|---|---|
| **Total** | **100** |

| | |
|---|---|
| **Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format) | |
| **1.** | Gerd Keiser, Optical Fiber Communications, 3rd Edition, McGraw-Hill International edition, 2000. |
| **2.** | John M. Senior, Optical Fiber Communications, 2nd Edition, PHI, 2002. |
| **3.** | H Nishihara, M Haruna and T Suhara, Optical integrated Circuits, McGraw-hill, 1989. |
| **4.** | D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Fiber Optic Communications, Pearson Education, 2005. |
| **5.** | C. R. Pollock and M. Lip Son, Integrated Photonics, Kluwer Pub., 2003. |
| **6.** | T. Tamir, (ed), Guided-wave optoelectronics, (2nd edition), Springer-Verlag, 1990. |
| **7.** | Clifford Pollock, Fundamentals of Optoelectronics, Richard Irwin Inc., Chicago, 1995. |
| **8.** | Journal articles i.e. IEEE, Springer, IOPscience, Elsevier and Video lectures from nanohub, NPTEL, MIT video lectures |
| **9.** | https://nptel.ac.in/courses/117/108/117108142/ |

**Detailed Syllabus**
**Lecture-wise Breakup**

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|---|---|---|---|
| **Course Code** | 17M12EC129 | **Semester Odd (specify Odd/Even)** | **Semester 2nd Session** 2019-20 **Month from** January to June |
| **Course Name** | Selected Topics in Wireless Communication | | |

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|---|---|---|---|
| **Credits** | 3 | **Contact Hours** | 3 |

| | | |
|---|---|---|
| **Faculty (Names)** | **Coordinator(s)** | Dr. Ankit Garg |
| | **Teacher(s) (Alphabetically)** | Dr. Ankit Garg |

| **COURSE OUTCOMES** At the end of the semester, students will be able to | | **COGNITIVE LEVELS** |
|---|---|---|
| CO1 | Learn how to find the moments of random distribution with the help of Moment Generating Function (MGF) | Understading Level (C150.2) |
| CO2 | Develop the ability to study different wireless fading channels/distributions and explore transmit and receive diversity | Applying Level(C150 .3) |
| CO3 | Analyze the performance of different fading channels in terms of BER, Outage Probability, Channel capacity etc., both without diversity and with diversity techniques | Analyzing Level(C150.4) |
| CO4 | Demonstrate the ability to comprehend and develop advanced wireless modeling techniques viz., MIMO, Cooperative communication, OFDM, etc. to test for improved performance. | Analyzing Level(C150.4) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | **Introduction, Probability and Random Process** | PDF, CDF, Random variable transformation, Moment Generating function (MGF), order statistics, Gaussian random variable, AWGN, PSD, Autocorrelation. | 6 |
| **2.** | **Fading and Wireless channel modeling** | Generic model for fading Channels, Composite fading channel model, Wireless Channel Fading and Distribution: Small scale, large scale and multipath fading channels. Rayleigh, Rician, Exponential, Nakagami-m, Chi-squared, Diversity modeling for Wireless Communications: Beamforming and MRC. | 8 |
| **3.** | **Performance Analysis of Wireless** | BER/SER Performance in Fading Channels for different modulation techniques, Maximal Likelihood, Zero Forcing and Minimum Mean Square Error | 12 |

| | | | |
|---|---|---|---|
| | **Communication System and Diversity** | Detection techniques, Channel capacity in AWGN, Outage Probability, Channel capacity for fading channel, capacity with channel side information(CSI) at receiver, capacity with CSI both at transmitter and receiver, Asymptotic Analysis, Coding gain, diversity gain. | |
| **4** | **Collocated and Distributed MIMO systems** | Introduction to MIMO, MIMO Channel Capacity, SVD and Eigen modes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBCs, Precoding, Introduction to Cooperative Systems: Amplify-and-Forward (AF), Decode-and-Forward (DF) based Cooperative Relaying – BER, Outage Probability and Diversity, Recent developments. | 12 |
| **5.** | **Introduction: OFDM Systems** | Introduction to Multicarrier Modulation, OFDM, Cyclic Prefix, SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues | 7 |
| | | **Total number of Lectures** | 45 |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25 (Attendance, Assignments, Quiz) |
| **Total** | **100** |

**Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)


| | |
|---|---|
| **1.** | Arogyaswami Paulraj, Dhananjay Gore, and Rohit Nabar, "Introduction to Space-Time Wireless Communications", Cambridge University Press, 2007 |
| **2.** | Erik G. Larsson and Petre Stoica, "Space-Time Block Coding for Wireless Communications", Cambridge University Press, 2003 |
| **3.** | Ezio Biglieri, "MIMO Wireless Communications", Cambridge University Press, 2007. |
| **4.** | Aditya K. Jagannatham, "Principles of Modern Wireless Communication Systems", McGraw-Hill Education, 2017 |
| **5.** | Marvin Kenneth Simon, Mohamed-Slim Alouini, "Digital Communication over Fading Channels", Willey, 2005. |
| **6** | K. J. Ray Liu, Ahmed K. Sadek, Weifeng Su, Andres Kwasinski, "Cooperative Communications and Networking", Cambridge University Press, 2009. |

**Detailed Syllabus**
**Lecture-wise Breakup**

| | | | |
|---|---|---|---|
| **Course Code** | | **Semester Odd (specify Odd/Even)** | **Semester Session Month from** |
| **Course Name** | Software Defined Radio and Cognitive Radio Network | | |
| **Credits** | 3 | **Contact Hours** | 3 |

| | | |
|---|---|---|
| **Faculty (Names)** | **Coordinator(s)** | Dr. Vivek Dwivedi |
| | **Teacher(s) (Alphabetically)** | NIL |

| **COURSE OUTCOMES** | | **COGNITIVE LEVELS** |
|---|---|---|
| **CO1** | Understand the concepts of Software Defined Radio (SDR) and its architecture | Understanding (Level II) |
| **CO2** | Understand the concepts of radio (CR) architecture, functions of cognitive radio | Understanding (Level II) |
| **CO3** | Analyzing the Spectrum sharing and management and Spectrum sensing methods | Analyzing (Level IV ) |
| **CO4** | Evaluating the performance ofNext GenerationWireless Networks | Evaluating (Level V) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| 1 | **Software Defined Radio (SDR)** | Essential functions of the SDR, SDR architecture, design principles of SDR, traditional radio implemented in hardware and SDR, transmitter architecture and its issues, A/D & D/A conversion, parameters of practical data converters, techniques to improve data converter performance, complex ADC and DAC architectures, digital radio processing, reconfigurable wireless communication systems. | 8 |

| | | | |
|---|---|---|---|
| **2.** | **Cognitive Radio (CR) features and architecture** | Cognitive Radio (CR) features and capabilities, CR functions, CR architecture, components of CR, CR and dynamic spectrum access, interference temperature, CR architecture for next generation networks, CR standardization. | 8 |
| **3.** | **Spectrum sensing** | Spectrum sensing and identification, primary signal detection. energy detector, cyclostationary feature detector, matched filter, cooperative sensing, spectrum opportunity, spectrum opportunity detection, fundamental trade-offs: performance versus constraint, sensing accuracy versus sensing overhead. | 10 |
| **4** | **Spectrum management of cognitive radio networks** | Spectrum decision, spectrum sharing and spectrum mobility, mobility management of heterogeneous wireless networks, Cooperation and cognitive systems and research challenges in CR | 10 |
| **5.** | **Next GenerationWireless Networks** | Control of CRN, Self-organization in mobile communication networks, security in CRN | 6 |
| | | **Total number of Lectures** | 42 |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25 |
| **Total** | **100** |

| **Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format) | |
|---|---|
| **1.** | Kwang-Cheng Chen and Ramjee Prasad, “Cognitive Radio Networks”, John Wiley & Sons, Ltd, 2009. |
| **2.** | Alexander M. Wyglinski, Maziar Nekovee, and Y. Thomas Hou, “Cognitive Radio Communications and Networks - Principles and Practice”, Elsevier Inc., 2010. |
| **3.** | Jeffrey H. Reed “Software Radio: A Modern Approach to radio Engineering”, Pearson Education Asia. |