INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

HIGH SPEED COMMUNICATIONS								
V Semester: ECE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AECD22	**Core**	3	-	-	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Digital communications								

I. COURSE OVERVIEW:

This course introduces the technologies used in high-speed communication systems. It covers both wireless systems like 4G, 5G, Wi-Fi, and wired systems like fiber-optic communication. Students learn about advanced digital modulation methods such as PSK, QAM, and MSK used to send data efficiently. The course explains how receivers detect signals and correct errors using methods like ML and MAP detection. It also covers equalization techniques to reduce signal distortion. MIMO systems are introduced to show how multiple antennas improve data speed and reliability. Multi-carrier systems like OFDM are discussed, which are used in many modern wireless networks. The course also includes signal processing tools like FFT and IFFT used in OFDM systems. Optical fiber communication is covered, including transmitters, receivers, and light-based modulation methods. Finally, students learn about WDM, optical amplifiers, and network types like SDH and PON used in fast optical networks.

II. COURSES OBJECTIVES:

The students will try to learn

I. Explore the principles and technologies behind high-speed communication systems- modulation and demodulation techniques over wireless media or optical fiber media.

II. Analyzing the receiver design for advanced modulations and channel impairment combating technique like equalization.

III. Comprehend the principles of MIMO system , diversity techniques and multi carrier systems for high performance of communication system.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1 Understand the concepts of advanced modulations and demodulation techniques for modern day high speed communication systems.

CO 2 Analyze the principles of optimal detection and different equalization techniques at receiver to retrieve the transmitted data.

CO 3 Understand MIMO system design that enables higher data speed through spatial multiplexing unlike SISO systems.

CO 4 Apply the different diversity techniques to combat the fading channel impairments.

CO 5 Analyze the design of multi-carrier and OFDM systems to enable high-speed communication.

CO 6 Understand the transmission technologies involved in fiber optic communication for gigabit transmission.

IV. COURSE CONTENT:

MODULE - I: INTRODUCTION AND ADVANCED MODULATIONS (10)
Introduction to high speed communication systems: wireless paradigm- Cellular: 4G,5G and Beyond; Wi-Fi standards, millimeter wave communications, wired paradigm- Fiber optic Communications: Gigabit Ethernet ; Advantages and challenges associated with HSC; Review of digital modulations, Advanced Modulations: M-ary Modulations, M-ary PSK, M-ary FSK, Orthogonal Pulse-Amplitude Modulation (OPAM), QAM, M-ary QAM, MSK, GMSK; Signal Space Representation of Waveforms, Signal constellation, power spectra, Spectral efficiency.

MODULE –II: OPTIMAL DETECTION AND EQUALIZATION AT RECEIVER (10)
Detection of a Signal Vector, Known Signals in Gaussian Noise, Maximum likelihood (ML) Detection, maximum a posteriori probability (MAP) detection, Symbol- Error Probability, Bit error probability of M-ary modulations. Linear equalization, Zero-Forcing Equalization, MMSE equalization, Decision Feedback Equalization, Adaptive ZF equalizer.

MODULE –III: MIMO COMMUNICATIONS AND DIVERSITY TECHNIQUES FOR HSC (10)
Review of SISO wireless systems, MIMO communication systems and Comparison of SISO and MIMO systems, MIMO channel models, Precoding designs in MIMO systems, Capacity of MIMO systems with and without channel state information at the transmitter, Spatial multiplexing, SDMA, Massive MIMO.

Types of Diversity- Receiver Diversity, Transmit Diversity and spatial diversity; Achieving diversity in MIMO systems with and without CSI at the transmitter, Alamouti's space-time code, Diversity-Multiplexing trade-off.

MODULE –IV: MULTICARRIER SYSTEM DESIGN FOR HSC (9)
Multi Carrier Communications, MCM transmission/Received signal, Orthogonal Frequency Division Multiplexing (OFDM), Modulation and Demodulation with OFDM system, Algorithm implementation IFFT/FFT of OFDM, peak to average power ratio in multi carrier Modulation, MIMO-OFDM system model, OFDMA.

MODULE –V: HIGH-SPEED OPTICAL FIBER COMMUNICATIONS (9)
Optical Sources: Lasers and LEDs; Optical fibers – types, modes, characteristics; Optical Receivers: Avalanche Photodiodes, Modulation Formats: OOK, 4-PAM, Coherent Modulation Techniques, Wavelength Division Multiplexing, Dense WDM, Optical Amplifiers: EDFA, Raman Amplifiers, Network Architectures: SONET/SDH, Optical Transport Network, Passive Optical Network.

V. TEXT BOOKS:

1. John G.Proakis, M.salehi "Digital Communications",McGraw Hill, 5th Edition, 2014.
2. A.Paulraj, R.Nabar & D.Gore, "Introduction to Space Time Wireless Communications", Cambridge University, 2008.
3. Keiser. G, "Optical fiber communications", Tata McGraw-Hill, 4 th Edition, 2008.

VI. REFERENCE BOOKS:

1. B.P.Lathi,"Modern Digital and analog Communication systems", Oxford press, 4th Edition, 2010.
2. J.Barry , E.A.Lee, and D.G.Messerschmitt "Digital Communication",Kluwer Academic Publishers, 3rd Edition, 2004.
3. Sung-Moon, Michael Yang, "Modern Digital Radio Communication Signals and Systems". Springer, 2nd Edition, 2021.
4. Theodore. S. Rapport, "Wireless Communications", Pearson Education, 3rd Edition, 2003.
5. Yong S. Cho, J. Kim, Won Y. Yang, Chung G. Kang, MIMO-OFDM Wireless Communications with MATLAB, Wiley-IEEE Press, 2011.
6. Tse, David, and Pramod Viswanath. "Fundamentals Of Wireless Communication", Cambridge, UK: Cambridge University Press, 2005.

VII. ELECTRONICS RESOURCES:

1. NPTEL :: NOC21_EE11 :Modern Digital communication techniques
2. NPTEL :: NOC24_EE72:Fundamentals of MIMO wireless Communication
3. NPTEL :: NOC20_EE79:Optic Communication Systems and Techniques

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open end experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper - II
9. Lecture notes
10. E-learning readiness videos (ELRV)
11. Power point presentation